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Three essays on international trade and economic development

A dissertation submitted in partial satisfaction of the
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by

Li Zhou

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The dissertation of Li Zhou is approved, and it is acceptable in quality and form for publication on microfilm and electronically:

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Chair

University of California, San Diego

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DEDICATION

To my mother and my grandmother

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ABSTRACT OF THE DISSERTATION

Three essays on international trade and economic development

by

Li Zhou

Doctor of Philosophy in Economics

University of California, San Diego, 2010

Professor James Rauch, Chair

This dissertation is composed of three self-contained chapters on international trade and economic development, with a special focus on the involvement of the government or public-funded sectors.

The first chapter investigates international trade of higher education, specifically its impact on native students and native workers in the exporting country. Theoretically, I show that, in a general equilibrium model with non-profit publicly-subsidized higher education providers (HEPs) that care about both education quality and the enrollment of native students, serving foreign students may improve natives' access to higher education, which eventually benefits all native workers. Empirically, I find that, during the period 2001 to 2007, the enrollment of one more foreign student in an Australian university leads to the enrollment of around 0.75

more native students in this university. The impact is identified using an instrumental variable, generated from the interaction between demand for Australian higher education from different countries during the sample period and student networks these countries had in different Australian HEPs during 1989 to 1994.

The second chapter studies commercial development in the presence of economic agglomeration of commercial goods and services, a result of consumers' love of varieties and transportation costs associated with commercial consumption. I show that a low-income community may be under-served with commercial goods and services because a developer cannot capture all the profits of a commercial project. A block grant to a developer can solve the market failure and generate a total profit bigger than the grant. Employment tax abatements alone are much less effective and much more costly.

The third chapter examines the long-run impact of trade in higher education. In an overlapping generation (OG) model with a higher education sector composed of non-profit research institutions and for-profit teaching institutions, I show that importing teaching services benefits low-ability individuals by increased number of research workers in production, and that it may also benefit high-ability individuals by providing better training to skilled workers to complement research workers.

Chapter 1

Distributing the gains from exporting higher education: evidence from Australia

1.1 Introduction

Trade in higher education has been growing fast in the past twenty years. The number of international students in higher education has increased from 1.1 million in 1985 to 3.0 million in 2007 (Education At a Glance, 2009). Higher education providers (HEPs) in the developed countries collect a significant amount of money as tuition fees from foreign students: In 2003/2004, UK HEPs received $3.8 billion from foreign students.[1] In 2007/2008, US HEPs and Australian HEPs received $7.4 billion[2] and $2.4 billion from foreign students respectively.

Despite the tuition revenue that foreign students contribute to the universities, exporting higher education is a controversial issue. The main concern is that foreign students may crowd out native students. An article in The Australian (December 2008) states that "the over-reliance on foreign students has led to an

[1]The $3.8 billion are tuition fees paid by non-EU students who are charged at a price higher than native UK students and students from EU countries.(Pamela Lenton 2007 "The value of UK education and training exports: an update")

[2]The $7.4 billion does not include financial supports from US institutions. It is tuition fees paid by foreign students with non-US sources. (US Open Doors 2008, Economic Impact Statement)

undercurrent of resentment among many young Australians, who feel these students are depriving them and their mates of places at good universities". Given the limited number of universities that a country has, it is natural for natives to perceive foreign students as competitors. It is also consistent with the conventional wisdom from the trade literature: when trade is induced by the difference in relative factor abundance, the owners of the scarce factor will lose from trade. It implies that native students in the education exporting country will be worse off because they have to compete with foreign students for the facilities and faculty that they had sole access to when the higher education sector is closed to foreigners.

The argument for the pure "crowd-out effect", however, neglects the potential positive impact that foreign students may have through their monetary contribution to universities. The Review of Australian Higher Education (submitted by The University of Melbourne, 2008, page 5) states that "we [universities] use international student fees to finance the education of Australian undergraduates, with no mechanism for making up the difference should Australia lose international market share". In a survey of three representative Australian universities, university executives unanimously claim that foreign students tuition revenue subsidizes native students and enables "better services and facilities" (Marginson and Eijkman, 2007). The evidence suggests that the revenue gain from exporting higher education is redistributed to native students through universities' resource allocation.

How exporting higher education affects native students and native workers is an important question that the economic literature has not yet answered. This paper contributes to the literature by offering both theoretical insights and empirical evidence on this issue. My theoretical innovation is introducing utility-maximizing universities from the higher education literature into a trade model. I show that native enrollment may increase with the inflow of foreign students ("crowd-in effect"), which is a sufficient condition for native workers to gain from exporting higher education.[3] My empirical innovation is constructing an instru-

[3]Here the assumption is that all students who enrolled in a HEP will graduate and become

mental variable using demand-driven variations to identify the impact of foreign enrollment on native enrollment. I find that during the period 2001 to 2007, Australian native enrollment increases with the inflow of foreign enrollment, suggesting that the non-profit nature of universities is critical to understanding the impact of exporting higher education.

The model uses a two-country Heckscher-Ohlin framework with a traded numeraire good and a traded education service. The goods production sector uses human capital and unskilled labor as inputs, and is private and competitive. The education production sector uses educational capital and research investment as inputs to produce education quality, and is composed of non-profit publicly-subsidized HEPs. HEPs value the enrollment of native students and education quality, which depends on the education inputs they own and their investments on quality improving activities. For each student they enroll, HEPs incur an enrollment cost, independent of the education quality. We can think of this enrollment cost as a custodial cost related to instruction (education core services) and ancillary services (transport, meals, housing) provided to students. HEPs receive funding from the government and collect tuition fees from students, and they allocate their income to quality improving activities and student enrollment to maximize their utility.[4]

In autarky, the education input scarce country (the Foreign country) has a lower education quality and less human capital per unskilled worker, which leads to a higher marginal value of human capital, skilled wage, and a lower marginal value of unskilled labor, unskilled wage. The value of Home education is higher for Foreign students than it is for native Home students. Assume HEPs in Home charge Foreign students tuition fees higher than the marginal enrollment cost. Foreign students generate extra revenue for Home HEPs. Through HEPs' increased spending on quality improvement activities, exporting higher education increases the quality of education and makes it more attractive to native students. Through

skilled workers with the same amount of human capital.

[4]The utility maximizing model of university behavior is extensively discussed in James (1990) and has motivated empirical studies regarding the enrollment of students supported by federal and institution funding (Ehrenberg 1993).

HEPs' extra subsidy to native enrollment, exporting higher education decreases the post-subsidy enrollment cost and makes it cheaper for native students. While these two mechanisms both lead to higher native enrollment, the inflow of foreign students drives up the marginal enrollment costs as long as the supply curve for university places is upward-sloping. The overall impact of exporting higher education on native enrollment therefore depends on the HEPs' preferences, the return to investment in quality improvement, the share of human capital in production, and the response of marginal enrollment costs to the inflow of foreign students. Native students do not lose on the quality dimension but could lose from a decrease of enrollment if the increase in marginal enrollment costs due to foreign students dominates the benefit from the quality improvement and increased subsidy.

The empirical section investigates the relationship between native enrollment and foreign enrollment across Australian HEPs during the period 2001 to 2007. I construct an instrumental variable using the variation in the number of foreign students driven by demand factors. This identification strategy is motivated by differences in demand for Australian higher education across student sending countries and across time, and by the network effects that have been found to be important in immigrant settlement patterns in the US (Card 2001 and 2009). For foreign students, existing networks reduce both the informational and mental costs involved in pursuing a degree in a different environment. Therefore, students from a specific foreign country are more likely to go to a university attended by a larger share of former students from this country. For example, students from Hong Kong are more likely to choose Monash University because some former students share their information with the applicants making Monash University more attractive to Hong Kong students. The interaction of the existing student networks, proxied by the HEP share distributions by sending country during the period 1989 to 1994, and the total demand for Australian higher education by sending country, proxied by the total number of students in Australian universities by country, generates variation in demand across HEPs across time.

The proposed instrument provides valid identification for the following reasons. First, the HEP share distributions are determined during the period 1989 to

1994, right after Australia opened its higher education sector to foreign students and before the unexpected cut in public funding due to political changes in 1996.[5] For individual universities, this was a period when exporting higher education offered windfall income and was not of strategic importance. Also, my sample period does not start until 2001, seven years after 1994. The changes in the international higher education market, for example, the sharp increase in demand from China, were hard to anticipate prior to 1994. Second, each university is small relative to the Australian higher education sector. During the entire sample period, no university has a market share higher than 9% of the Australian exporting market. As long as each HEP is small, the number of foreign students in Australia on average should not be correlated with unobserved HEP- and year-specific errors in native enrollment. As a robustness check, I use the number of students studying anywhere abroad by country to substitute the number of students in Australia by country in constructing the instrument.

In a reduced-form specification that controls for HEP-fixed effects, HEP-fixed trends, and year fixed effects, I relate the number of native students in a HEP to the number of foreign students in this HEP. Foreign enrollment is treated as endogenous and instrumented by the variable constructed from the demand factors as described. The IV estimate suggests that the enrollment of one more foreign student in a particular Australian university increases this university's enrollment of native students by 0.75 with a standard error of 0.29.

In a regression that relates HEP-level native enrollment to tuition revenue from foreign students, the IV estimate shows that an increase of A$10,000 (constant 2000) in tuition revenue collected from foreign students by a university would lead to the enrollment of 0.8 more native student in this university. During the sample period, each foreign student brought $A\$7,929$ on average. The estimated impact of foreign students' revenue on native enrollment implies that the enrollment of one more foreign student leads to the enrollment of about 0.63 more native students. Also, the HEP level enrollment gain is similar to the state level gain identified with

[5]The Australia Labor Party lost the election to the Liberal-National Coalition in 1996. The new government significantly cut public funding to higher education.

a similar instrument, suggesting that there is no spillover across HEPs within a state. The estimated coefficients of foreign enrollment imply that, given the realized public funding, if there had been no increase in foreign enrollment Australian native enrollment would have declined annually by around 5000 on average during the period 2001 to 2007 as opposed to observed annual growth of 7,154. The evidence suggests that the sufficient condition for native students and workers to gain from exporting higher education is satisfied for this specific period.

The rest of the paper is organized as follows. In Section 2, I set out the model in a closed economy, derive the trade pattern, and analyze the impact of trade in higher education on the exporting country. In Section 3, I present the empirical specification, explain the instrumental variable, and discuss the empirical results. Section 4 concludes.

1.2 Theoretical model

1.2.1 A closed economy with a publicly-subsidized higher education sector

I consider a closed economy with a competitive production sector and a publicly-subsidized higher education sector.

Individual

There are N individuals in this economy. Individuals are endowed with 1 unit of time. They can spend all their time working as an unskilled worker, or they can get higher education and become skilled workers. To get higher education, individuals have to pay tuition p and spend a fixed share θ of their time in school.

The net lifetime income of skilled workers is the wage income W_s minus the tuition p, and the lifetime income of unskilled workers is the unskilled wage W_u. Because individuals are identical, they have the same net income in equilibrium regardless of their education choices, which means that p will be the difference between the wage income of the two types of workers:

$$p = W_s - W_u \tag{1.1}$$

Production Sector

The production sector uses human capital, H, and unskilled labor, L_u, to produce a composite good, Y. The technology is given by a Cobb-Douglas production function

$$Y = H^\alpha L_u^{1-\alpha}$$

where human capital equals the product of the total work time of skilled workers, $(1-\theta)L_s$, and their education quality, q, i.e., $H = (1-\theta)L_s q$.

Human capital and unskilled labor are paid competitively at their marginal value

$$W_h = \alpha \left(\frac{H}{L_u}\right)^{\alpha-1} \tag{1.2}$$

$$W_u = (1-\alpha)\left(\frac{H}{L_u}\right)^{\alpha}. \tag{1.3}$$

The wage income of a skilled worker is, therefore, the product of his or her work time $(1-\theta)$, the amount of human capital q, and its marginal value W_h, or $W_s = (1-\theta)qW_h$.

Higher Education Sector

There are n identical HEPs, each endowed with education input K and receiving public funding g from the government as a block grant. [6]HEPs value education quality q and the number of native students S enrolled. Their preference is given by $U(q, S) = q^\sigma S^{1-\sigma}$ and $0 < \sigma < 1$. An increase in σ means an increase in HEPs' preference towards education quality.

[6]In Australia, HEPs receive both block grants from the Commonwealth Government and a per student subsidy through Higher Education Contribution Scheme (HECS). Since the per student subsidy does not cover the marginal enrollment cost, I assume it to be zero without loss of generality.

A university's educational quality q increases with its endowment of education input and its investment in quality improvement R, and takes the functional form as

$$q = KR^{\beta} \tag{1.4}$$

where $0 < \beta < 1$ implies decreasing marginal returns to research investment. Education quality is a pure public good within a HEP.

For each student they enroll, HEPs incur an enrollment cost c and receive tuition p from the student. The representative HEP behaves as a price-taker, treating tuition p, marginal cost c, and government subsidy g as given, and chooses quality investment R and student enrollment S to maximize its utility:

$$\max_{R,S} q^{\sigma} S^{1-\sigma} = K^{\sigma} R^{\beta\sigma} S^{1-\sigma}$$
$$\text{s.t. } R + cS \leqslant g + pS.$$

The research investment of the representative HEP is given by

$$R = \frac{\beta\sigma g}{1-(1-\beta)\sigma}. \tag{1.5}$$

As expected, the research investment R is increasing in β and σ, which means that a HEP which is more productive in quality improvement (corresponding to a bigger β) or has a stronger preference for quality (corresponding to a bigger σ) will devote more revenue to quality improving activities.

The enrollment of the representative HEP is determined by the following equation

$$c - \frac{1-\sigma}{1-(1-\beta)\sigma} \frac{g}{S} = p \tag{1.6}$$

The left hand side of this equation is the post-subsidy marginal enrollment cost. Notice that the tuition p is smaller than the marginal enrollment cost c, i.e., students are subsidized by the block grant g. Here the block grant affects the enrollment of native students because HEPs are utility maximizers and they value native enrollment, i.e., the block grant has an income effect.

Equilibrium in a closed economy

An equilibrium for this economy is an investment in quality improvement R, an educational quality q, an enrollment of students S, a tuition p, a distribution of educated and uneducated workers $\{L_s, L_u\}$, and a return to human capital and unskilled labor, $\{W_h, W_u\}$ such that 1) HEPs maximize their total output of human capital subject to their budget constraints; 2) individuals are indifferent between the two education choices; 3) production firms maximize their profits; and 4) the two factor markets clear.

The investment in quality improvement is given by equation (1.5), independent of other endogenous variables. And it determines the educational quality as in Equation (1.4). The rest of the 6 unknowns, $\{S, p, L_s, L_u, W_h, W_u\}$, are determined by equations (1.1),(1.2),(1.3),(1.6) and the two factor-market-clearing conditions $L_s = nS$ and $L_u = N - L_s$.

Plugging equations (1.3),(1.6), $L_s = nS$, and $L_u = N - L_s$ into equation (1.1), we get the tuition equation

$$p = (1-\theta)^\alpha q^\alpha \left[\alpha \left(\frac{nS}{N-nS} \right)^{\alpha-1} - (1-\alpha) \left(\frac{nS}{N-nS} \right)^\alpha \right]. \qquad (1.7)$$

Equation (1.7) shows that individuals are willing to pay higher tuition for better educational quality q, and that their willingness to pay decreases with the number of students S in representative universities.[7] In other word, it is a downward-sloping inverse demand curve for university places.

If we plug equation (1.7) into equation (1.6), we can see the enrollment of students S is determined by

$$c - \frac{1-\sigma}{1-(1-\beta)\sigma} \frac{g}{S} = (1-\theta)^\alpha q^\alpha \left[\alpha \left(\frac{nS}{N-nS} \right)^{\alpha-1} - (1-\alpha) \left(\frac{nS}{N-nS} \right)^\alpha \right]. \qquad (1.8)$$

---

[7] $\frac{\partial p}{\partial q} = \alpha(1-\theta)^\alpha q^{\alpha-1} \left[\alpha \left(\frac{nS}{N-nS} \right)^{\alpha-1} - (1-\alpha) \left(\frac{nS}{N-nS} \right)^\alpha \right] = \frac{\alpha}{q} p \geqslant 0$

$\frac{\partial p}{\partial S} = \frac{\alpha(\alpha-1)nN^2(1-\theta)^\alpha q^\alpha}{(N-nS)^3} \left(\frac{nS}{N-nS} \right)^{\alpha-2} < 0$ and $\lim_{S\to 0} p = +\infty$.

The left hand side of equation (1.8) is the marginal enrollment cost minus the per student public subsidy. In other words, it is the representative HEP's inverse post-subsidy supply of university places. The post-subsidy supply is upward-sloping in S assuming the marginal enrollment cost is increasing in nS. An increasing marginal enrollment cost reflects the fact that there is a limited pool of potential instructors, classroom and office space, etc..

Equation (1.8) shows that the equilibrium level of student enrollment S is determined when the individual's willingness to pay for higher education equals the post-subsidy marginal enrollment cost. Figure 1 illustrates the existence and uniqueness of the equilibrium (proof is in the Appendix).

Once S and p are determined, L_s, L_u , and $\{W_h, W_u\}$ will be pinned down in turn by the factor market clearing conditions and equations (1.2) and (1.3).

Analysis of the equilibrium

We can now analyze the comparative statics of the model. The comparative statics analysis of changes in K, β (σ), g, and N is summarized in Table 1.1. In this section, I will show how a change in the variable of interest K, the education input that each HEP owns, changes the equilibrium outcome. The comparative analysis of other variables (β, g, and N) is done in the Appendix.

Figure 1.2 shows the impact of an increase in K. An increase in the education inputs that each HEP owns, increases the quality of education, so the inverse demand curve shifts up. Since the increase in K has no impact on the HEPs' revenue allocation, the inverse post-subsidy supply curve does not change given the marginal enrollment cost and government subsidy. Therefore, the equilibrium number of students S and tuition p will both increase. The amount of unskilled labor, L_u, decreases as a consequence of more individuals choosing to get higher education. The aggregate level of human capital H increases because both education quality q and the number of skilled workers nS increases. The increase in human capital per unskilled worker, $\frac{H}{L_u}$, leads to a decrease in the marginal value of human capital and an increase in the wage of unskilled worker. Therefore, the net lifetime income of all workers increases.[8]

Notice that K is at the HEP level, and the aggregate education inputs and public funding is nK. An increase in K is equivalent to an increase of the relative abundance of education inputs nK/N.

1.2.2 Trade pattern

I now examine trade in higher education in a world with two countries, Home and Foreign. Suppose home is the education input abundant country, i.e., $nK/N > n^*K^*/N^*$, and the two countries have the same number of HEPs per person and same public funding to a HEP, i.e. $n/N = n^*/N^*$ and $g = g^*$. This condition is equivalent to $K > K^*$. The comparative statics in the previous section suggests that, in autarky, Home has a higher educational quality ($q > q^*$), more students per HEP ($S > S^*$), higher tuition ($p > p^*$), more human capital per unskilled worker ($\frac{H}{L_u} > \frac{H}{L_u}^*$), a higher lifetime income per person ($W_u > W_u^*$), and a lower return to human capital ($W_h < W_h^*$). I demonstrate in this section that once the two countries open to trade, the only possible trade pattern that is that home exports educational services and imports the numeraire good.

Consider an individual born in Foreign who has to decide whether or not to acquire higher education from Home. To this individual, the net benefit of getting educated in Home and working in Foreign is

$$\widetilde{p}_f = (1-\theta)qW_h^* - W_u^*.$$

$\widetilde{p}_f$ is positively related with the marginal value of human capital and negatively related with the opportunity cost. For the same education quality q, individuals from Foreign will get a higher return for their human capital ($W_h < W_h^*$). Their opportunity cost, the wage for unskilled labor, is lower than that of individuals born in Home ($W_u > W_u^*$). Therefore, Home education is more valuable for individuals from Foreign than it is for individuals born in the Home country. Hence foreigners are willing to pay a higher tuition fee than natives, i.e., $\widetilde{p}_f > p$.[9]

[8] $W_s - p$ can increase even though p increases and W_h decreases because q increases.

[9] $\widetilde{p}_f - p = [(1-\theta)qW_h^* - W_u^*] - [(1-\theta)qW_h - W_u]$

On the other hand, for an individual born in Home who also has the option of acquiring higher education from either Home or Foreign, the willingness to pay for getting education in the Foreign country and working in Home is

$$\widetilde{p}_f^* = (1-\theta)q^* W_h - W_u.$$

It is lower than the prevailing tuition in Foreign, $\widetilde{p}_f^* < p^*$. The logic is the same as before: individuals from Home get a lower marginal return for human capital but face a higher opportunity cost. For the same education quality, they are not willing to pay tuition as high as individuals from Foreign are willing to pay. Therefore, even though tuition is lower in Foreign, it is not low enough to attract individuals born in Home.

Assuming no HEPs charge foreign students lower tuition fees than what they charge their native students, no individuals born in Home will have an incentive to study in Foreign. Individuals born in Foreign will want to study in Home as long as the tuition fees that Home charges for foreign students are not higher than $\widetilde{p}_f$.

Proposition 1. *In a world with two countries that differ in the relative abundance in education capital, the education capital abundant country will export education service and will receive the numeraire good as payments from the education capital scarce country.*

The trade pattern is consistent with the implication of the Heckscher-Ohlin Theorem that the education input abundant country exports higher education, which uses the education input, to the educational capital scarce country and imports the numeraire goods, which does not use the education input directly. A slight difference is that here the country with higher tuition will export educational services to the country with lower tuition.

1.2.3 Tuition policy for foreign students

I assume HEPs charge foreign students tuition fees that are higher than the marginal enrollment cost. This assumption is abstracted from the practices of the

$= (1-\theta)q(W_h^* - W_h) + (W_u - W_u^*) > 0$

UK, Australia, New Zealand, and the US (at the undergraduate level).[10]

Let p_f be the tuition fee that HEPs in Home charge for students from Foreign. I assume it is set as

$$p_f = c + \pi, \pi > 0 \tag{1.9}$$

In this regime, foreign students need to pay the marginal enrollment cost c and a positive markup π. Recall that there are $n > 1$ identical institutions in the higher education sector. Without regulation or collective strategies, competition among the HEPs for foreign students will drive the tuition fees down to the marginal enrollment cost. So, the existence of a positive markup effectively states that the higher education sector is not in perfect competition. This is not surprising given the history of the higher education system. In Australia, the positive markup is sustained through the minimum indicative fees set by Department of Education, Science and Training (DEST). HEPs are not allowed to charge a fee lower than the corresponding minimum indicative fee, which is supposed to reflect the full average cost of providing a place.[11] the UK had the same regulation until 1993/1994, and according to the United Kingdom Committee of Vice-Chancellors and Principals, the tuition levels in 1997 were clustered around the recommended minimum fees at the time.[12]

Further, I assume π is an exogenous positive number. This assumption is made for two reasons: first, in Australia, p_f represents the long run average cost which include the marginal cost, overhead cost, and capital cost. Second, abstracting from the determination of π allows us to focus on the benefit of the

[10] If HEPs in the education input abundant country charge the same level of tuition on both native students and foreign students, because of the government subsidy, this tuition is lower than the marginal enrollment cost. In this case, foreign students effectively take away funding from native students, thus crowding them out.

[11] The full average cost of providing a place has different components including teaching and research, administration, overhead, and capital facilities, course-specific (e.g., lab) or common-used (library).

[12] The information is mostly from a report on comparative costs of international students by Beck, Davis, and Olsen (1997), in which they discussed how the fees for international students were set for Australia, the UK, the US, New Zealand, and Canada. There is a newer report on the subject done in 2004 by Follari which I have not gained access to yet. The bottom line is the higher education sector in major exporting countries was not in perfect competition.

extra revenue and the cost of generating this revenue. As discussed at the end of the previous section, individuals born in Foreign will seek education in Home if $p_f < \widetilde{p}_f$.

1.2.4 Equilibrium in the open economy

The trade equilibrium is characterized by, in addition to variables that are analyzed in the closed economy, the number S_f of Foreign students studying in Home representative HEP, and tuition fees p_f these students need to pay.

Equilibrium conditions

In the Foreign country, the research investment R^* and education quality q^* remains the same because public funding to representative HEPs is the same and they do not have foreign students. Opening to trade, Foreign individuals have the choice of Home higher education. With free trade, individuals should be indifferent between Home higher education, Foreign higher education and no higher education:

$$W_u^* = (1-\theta)qW_h^* - p_f \tag{1.10}$$

$$W_u^* = (1-\theta)q^*W_h^* - p^*.$$

The aggregate human capital in Foreign now equals the human capital of the Home educated plus the human capital of the Foreign educated, $H^* = nqS_f + nq^*S^*$, and the unskilled labor equals $L_u^* = N - nS^* - nS_f$. The change in the ratio of aggregate human capital to unskilled labor changes the value of human capital in the Foreign country, and therefore individuals' willingness to pay for Foreign higher education, p^*. Similar to the closed economy, enrollment in the representative HEPs in Foreign, S^*, is determined by the inverse supply of and inverse demand for higher education places

$$c(nS^*) - \frac{1-\sigma}{1-(1-\beta)\sigma}\frac{g}{S^*}$$
$$= (1-\theta)^\alpha[q^*\alpha(\frac{nqS_f + nq^*S^*}{N - nS^* - nS_f})^{\alpha-1} - (1-\alpha)(\frac{nqS_f + nq^*S^*}{N - nS^* - nS_f})^\alpha] \tag{1.11}$$

In the Home country, the representative HEPs now have three revenue sources: government funding, tuition from native students, and tuition from foreign students $p_f S_f$. Foreign students pay $p_f S_f$ to the HEP as tuition fees and the HEP spends cS_f on activities associated with their enrollment. The extra revenue that a HEP collects is πS_f. The budget constraint of representative HEPs is therefore

$$R + (c - p)S \leqslant g + \pi S_f$$

As in the closed economy, the representative HEP allocates the total revenue $g+\pi S_f$ on quality improvement and educating native students to maximize its total human capital output. The investment in quality improvement and the resulting education quality in Home are determined by the following equations.

$$R = \frac{\beta\sigma(g + \pi S_f)}{1 - (1 - \beta)\sigma} \tag{1.12}$$

$$q = K \left[\frac{\beta\sigma(g + \pi S_f)}{1 - (1 - \beta)\sigma}\right]^{\beta} \tag{1.13}$$

Native enrollment S in Home representative HEP is determined by

$$c[n(S + S_f)] - \frac{(1 - \sigma)(g + \pi S_f)}{1 - (1 - \beta)\sigma}\frac{1}{S} = (1 - \theta)^{\alpha} q^{\alpha} \left[\alpha \left(\frac{nS}{N - nS}\right)^{\alpha - 1} - (1 - \alpha)\left(\frac{nS}{N - nS}\right)^{\alpha}\right]. \tag{1.14}$$

Compared to the autarky equilibrium, the trade equilibrium has two extra equations: one is the tuition Home HEPs charge Foreign students (equation 1.9) and the other is the non-arbitrage condition between Home education and being an unskilled worker in Foreign (equation 1.10) for people born in the Foreign country. These two equations combined with the marginal values for human capital and labor and the two market clearing conditions in Foreign, yield

$$c[n(S + S_f)] + \pi = (1 - \theta)^{\alpha}[\alpha q(\frac{nqS_f + nq^* S^*}{N - nS^* - nS_f})^{\alpha - 1} - (1 - \alpha)(\frac{nqS_f + nq^* S^*}{N - nS^* - nS_f})^{\alpha}]. \tag{1.15}$$

Determination of the equilibrium

As in the closed economy case, the investment in quality improvement $R^{(*)}$ and education quality $q^{(*)}$ is determined independently in the higher education sector of each country. Equations (1.11) and (1.14) identify a unique S^* and S in Foreign and Home for any given S_f: the inverse supply curve of higher education places to natives is still upward-sloping, the inverse demand of natives for higher education places is still downward-sloping, and the two curves intersect only once (See Appendix for proof). The equilibrium enrollment and tuition $\{S^{(*)}, p^{(*)}\}$, in turn, determine the distribution of workers $\{L_s^{(*)}, L_u^{(*)}\}$, and the marginal values of human capital and unskilled labor $\{W_h^{(*)}, W_u^{(*)}\}$. To show that the trade equilibrium exists and is unique, I need to show that there exists a unique S_f. I will do this by showing that equation (1.15) has a unique solution: the inverse supply of Home higher education places to Foreign students is upward-sloping and the inverse demand for Home higher education places from Foreign students is downward-sloping, and the two curves intersect only once (See Appendix for proof). Here I will give the intuition.

Consider the left-hand side of equation (1.15). It is the tuition p_f Home HEPs charge for Foreign students' education, or the inverse supply of Home higher education places to Foreign students. When there are more foreign students in the Home country, the marginal enrollment cost increases in Home, so the tuition Foreign students pay for Home education increases.

Now consider the right-hand side of equation (1.15). It is the net benefit $\widetilde{p}_f$ of Home education to a Foreign individual, or the inverse demand for Home higher education places from Foreign students. As the number of Foreign students in the Home country increases, in Foreign the marginal value of human capital decreases and the opportunity cost of getting higher education increases, hence Foreign students' willingness to pay for Home education decreases. At the same time, the increase of Foreign students in Home improves Home education quality, and increases Foreign students' willingness to pay for Home education. For the inverse demand curve to be downward-sloping, the impact on quality improvement in Home should be dominated by the impact on marginal values of human capital and labor in Foreign. The diminishing return on quality improvement investment ensures that, when S_f is big enough, the increased benefit of getting Home education due to an increase in q from the increased investment in quality improvement will be dominated by the effects that decrease the net benefit of Home education.

The assumption that $p_f(S_f = 0) < \widetilde{p}_f(S_f = 0)$ makes sure that the intercept of the inverse supply curve is smaller than the intercept of the inverse demand curve. Hence there must be a unique S_f that satisfies equation (1.15) (See Appendix for proof).

1.2.5 Impact on the education exporting country

I now examine the impact of Foreign students on the education exporting country, Home. To do this, I contrast the autarky equilibrium with the trade equilibrium. Let $S_f > 0$ be the equilibrium number of Foreign students studying in a representative HEP in Home and $\{S^a,\ p^a,\ L_s^a,\ L_u^a,\ W_h^a,\ W_u^a\}$ denote the variables in autarky. I use the notation of the previous section for all variables and equations pertaining to the trade equilibrium. Equation (1.12) shows that Home HEPs increase the investment in quality ($R > R^a$) and the education quality increases as well ($q > q^a$).

The increase in education quality increases natives' willingness to pay for education, which means that the inverse demand curve shifts up as shown in Figure 2. Foreign students have two forms of impact on the inverse post-subsidy supply of the HEPs, the left-hand side of equation (1.14). First, HEPs allocate $\frac{\pi S_f}{1+\beta}$ to subsidize native students, which brings down HEPs' inverse post-subsidy supply. Second, the inflow of Foreign students bids up the marginal enrollment costs and shifts up the inverse supply to native students. The overall impact of Foreign students on the inverse post-subsidy supply of Home HEPs is not clear. If the inverse post-subsidy supply shifts up more than the inverse demand does, point B is the trade equilibrium. Compared to the autarky equilibrium (point A), the equilibrium enrollment will fall ($S < S^a$) and the equilibrium tuition will increase ($p > p^a$). If the inverse post-subsidy supply shifts down or shifts up but less than the inverse demand does, point C is the trade equilibrium, and the equilibrium enrollment will increase ($S > S^a$). The equilibrium tuition may decrease or increase.

The income of natives is measured by the wage of unskilled workers, which is positively correlated with human capital per unskilled worker in production. The stock of human capital is the product of the quality of education and the number of college educated workers. If the number of college educated workers increases ($S > S^a$), then the stock of human capital increases ($qL_s > q^a L_s^a$) because education quality is higher with trade, and the number of unskilled workers decreases ($L_u > L_u^a$). As a consequence the income of natives increases ($W_u > W_u^a$). If the number of college educated workers decreases, then the impact on the lifetime income of natives will be ambiguous.

The impact of foreign students on the education exporting country is summarized in the following proposition.

Proposition 2. *If the HEPs, who value education quality and native enrollment, charge foreign students a tuition fee higher than the marginal enrollment cost,*

- *Home investment in quality will increase and hence Home education quality increases;*
- *the change in native enrollment will be positive if the overall impact of extra revenue on supply and demand dominates the impact on the marginal enrollment cost, and the change in native enrollment will be negative otherwise.*
- *the income of native workers will increase if aggregate native enrollment increases. In other words, an increase in aggregate native enrollment is a sufficient condition for native workers to be better off.*

1.3 Empirical Evidence from Australian HEPs

The theoretical analysis generates an important empirical question: how does native enrollment respond to the export of higher education? To answer this question, I investigate the relationship between native enrollment and foreign students using data from Australia.

1.3.1 Empirical specification

The empirical analysis uses institution-level enrollment data from the Australian higher education sector during the period 2001 to 2007. Consider the following specification that seeks to explain the number of native students in HEP i in academic year t (S_{it}). This specification relates the number of native students to the number of foreign students ($S_{f,it}$) :

$$S_{it} = \delta + \phi_{1i} + \phi_{2i}t + \gamma S_{f,it} + \lambda_t + \varepsilon_{it} \tag{1.16}$$

Here ϕ_{1i} and ϕ_{2i} are HEP fixed effects and fixed trends; λ_t are year fixed effects. ε_{it} are the unobserved HEP- and year-specific errors.

The HEP fixed effects absorb any time-invariant HEP-specific factors (e.g., selectivity) that may affect the size of native enrollment. In addition, the HEP fixed trends absorb any HEP-specific factors that may affect the growth of native enrollment and the year fixed effects absorb any year-specific factors (e.g., funding available to the higher education sector, and native population interest in pursuing higher education). γ measures the response of native enrollment to foreign enrollment at the HEP level. Before describing the steps that I take to ensure γ can be interpreted as the causal effect of foreign enrollment on native enrollment, I discuss the sources of variation in foreign enrollment generated by the supply side.

Fundamental supply factors, for example, the marginal enrollment cost in the model, affect the enrollment of foreign students. A HEP that improves its efficiency in educating students will have lower tuition fees and enroll more foreign students. Also HEPs may enroll more foreign students due to negative shocks in public funding. In a case study of three representative Australian universities,[13] Marginson and Eijkman (2007) stated "As at the other universities, at South Australia it was noted that the rapid growth of international education had been

[13]University of Melbourne, University of South Australia, and University of Ballarat

driven by the reductions in per capita public funding." A financially distressed HEP may have to cut the enrollment of native students; however, its ability to serve foreign students does not change because foreign students pay the full cost of their education. This HEP may become more active in the international market and enroll more foreign students in order to generate income.

The variation in foreign enrollment generated by the supply side is correlated with variation in the native enrollment. And as analyzed above, the correlation can be positive or negative. To identify γ, I propose an instrumental variable that uses variation in foreign enrollment driven by demand factors.

1.3.2 Instrumental variable approach

The instrumental variable is motivated partly by the difference in the clustering patterns of students from different sending countries in different Australian HEPs. For example, in 2001, The University of New South Wales enrolled 10% of all Chinese students in Australia and only 2.2% of Indian students and 2.8% of Malaysian students. Monash University enrolled 11% of students from Singapore and only 2.3% of students from the US. These statistics show different student sending countries have different connections with Australian HEPs. What determines the connections? There are at least two different forces. One force is from the HEPs' side: different HEPs choose to promote their education in different countries. For example, Central Queensland University may have hired recruiters in India and successfully attracted 18% of Indian students in 2001, while it only attracted 2% of the students from Singapore. Another force is the existing social networks that countries have in different HEPs, which induces different preferences towards Australian HEPs in students from different sending countries. This is a force from the demand side that I will discuss and explore in detail.

Social networks have been found important in determining the settlement of new immigrants (Card, 2001 and 2009). Foreign students, though not usually legally categorized as immigrants, are a population of young people who leave their home country and live in a foreign country for a significant amount of time.

They have to apply to institutions in a different higher education system, live in a foreign environment, and study very possibly in a different language. An existing student network from the same sending country may offer valuable information and other benefits, starting from the application process, to initial orientation, to forming study groups, to finding internships, and to graduating with a job. In many ways, social networks may lower mental costs and physical costs of pursuing higher education in a foreign country. The strength of the social network in a particular university affects the attractiveness of this university to students from the same sending country. For example, students from Hong Kong are more likely to go to Monash University because they know people who go (or went) to this university and who share their information and experience.

An immediate concern is of course how to separate social networks from HEPs' strategic recruiting. The way I deal with the problem is to use the clustering pattern established during the period 1989 to 1994. This is a period right after Australia opened its higher education sector to foreign students, and before the big cut of public funding to higher education that happened when the Australian Labor Party lost the election in 1996 after 13 years of governance. For individual HEPs, this was a period when exporting higher education offered windfall income and was not of strategic importance. Also, it is very unlikely for any single Australian HEP to anticipate the development of the international education market, for example, the sharp increase in demand from China. And finally, my sample period does not start until 2001, seven years after 1994. It is hard to imagine that the average share distribution pattern during the initial period is the result of HEPs' long-run strategic planning. For that to happen, we would have to believe that a HEP had a ten to fifteen year growth plan, felt the need to use the international market as an income source when it had stable public funding, and foresaw the future developments in the international market. If instead we believe that, during the initial period, Australian HEPs are not active individually in the international higher education market, then the student clusters are determined by past circumstances, such as the openness of the university or involvement in international cooperation even before 1989. These past circumstances do not vary over time and hence should not correlate with HEP- and year-specific errors in native enrollment during the sample period.

The time variation in the instrument comes from variation in the demand for Australian higher education across student sending countries and across time. Some of the variation across time is generated by the fluctuation of exchange rates during this period. Foreign students, unlike native students, are affected by exchange rates of the Australian dollar against their local currency. If the Australian dollar depreciates, then the price of Australian higher education decreases and foreign enrollment will increase. As long as the supply of places to foreign students by HEP is not perfectly inelastic, variation in exchange rates will generate variation in foreign enrollment across time. The Australian dollar depreciated from 0.65 US dollars at the end of 1999 to 0.49 US dollars in March 2001, and did not recover to the 1999 level until May 2003, then it kept appreciating to around 0.95 US dollars in July, 2008.

Variation in the demand for Australian higher education is also generated by characteristics of the sending countries, for instance, college-age population, economic development, labor market conditions, and the development of its own higher education sector. For example, China and India both have a big and fast-growing population and economy, and an underdeveloped domestic higher education sector, yielding big and fast-growing demand for Australian higher education. Singapore and Hong Kong used to have a high demand for Australian higher education, but their demand decreased when they decided to develop their higher education sectors and to become Asian education hubs. These country-specific time-varying factors are independent of Australia as a country, let alone individual Australian HEPs.

The interaction between time-invariant differences in preferences towards HEPs across sending countries and variation in demand for Australian higher education across sending countries and across time generates variation in foreign enrollment at the HEP level that is not correlated with HEP- and year-specific errors in native enrollment. In this section, I use the number of students from each sending country to proxy this country's demand for Australian higher education.

For each country, I take the total number of students in a given year and assign the students to different HEPs according to the share distribution in the initial period. For each HEP, summing the assigned number of foreign students over the sending countries gives the predicted enrollment of foreign students in that year.

Formally, let F_{jt} indicate the number of foreign students from sending country j who study in Australian universities in year t, and let η_{ij} indicate the share fraction of foreign students from country j enrolled in HEP i during the period 1989 to 1994. The number of foreign students from country j who would be predicted to enroll in HEP i in year t equals $\eta_{ij} F_{jt}$. Summing over student sending countries, the predicted foreign enrollment in HEP i in year t is

$$\widehat{S}_{f,it} = \sum_j \eta_{ij} F_{jt} \tag{1.17}$$

With the predicted foreign enrollment, I then estimate a system of equations of the following form:

$$\begin{aligned} S_{f,it} &= \eta + \theta_{1i} + \theta_{2i} t + \gamma_1 \widehat{S}_{f,it} + \psi_t + \upsilon_{it} \\ S_{it} &= \delta + \phi_{1i} + \phi_{2i} t + \gamma_2 S_{f,it} + \lambda_t + \varepsilon_{it} \end{aligned} \tag{1.18}$$

Using the predicted foreign enrollment $\widehat{S}_{f,it}$ as an instrument for the actual foreign enrollment $S_{f,it}$, along with HEP fixed effects, HEP fixed trends, and year-fixed effects in equation (1.18), the impact of foreign enrollment γ_2 is identified by the pattern of demand-driven variation in foreign enrollment that leads to deviation in the native enrollment around the HEP fixed time trend.

1.3.3 Data

Since 1989, the Department of Education, Science and Training (DEST)[14] has collected a wide range of student characteristics in higher education, including the number of students by institution, by detailed classification of fields, and by country of birth. The main regression uses the Student Enrollment Data from 2001

[14]Department of Education, Employment, and Work Relations (DEEWR) since December 2007

to 2007. The instrumental variable is constructed using foreign enrollment data by country of origin and by institution for the period 1989 to 2007. Enrollment is an unduplicated count of the number of students who enrolled in at least a major or minor course in the reference school year, regardless of their type or mode of enrollment.

There are between 47 and 105 HEPs each year that reported their enrollment data, for a total potential sample of 459 observations during the period 2001 to 2007. The analysis is restricted to the 39 HEPs that have reported enrollment data every year since 2001. The 39 HEPs enrolled 92.6% of students who enrolled in the 105 HEPs in the year 2007.[15]

I use the enrollment of foreign students by country of birth during the period 1989 to 1994 to calculate the institution share distributions for the 90 countries and regions[16] that had students in Australian higher education institutions during that period. The predicted institution-level foreign enrollment is then constructed using the historical institution share distributions and the number of foreign students from the 90 sending countries and regions from 2001 to 2007.

Table1.2 presents the historical share distributions of the top 10 student sending countries and regions among the "Group of Eight"[17] institutions. I want to point out two patterns. First, there are differences in the share distributions of different sending countries. For example, the University of New South Wales enrolled 10.8% of US students but only 1.8% and 2.2% of students from Singapore and Japan, respectively. The 8 universities enrolled 31.4% of US students but only 12.7% of Indian students. Second, the shares are relatively small. The first pattern suggests that the historical share distribution will generate variation in the number of foreign students across universities in a given year, which is a necessary condition for the instrument to work.[18] The second pattern suggests that individual HEPs

[15]A list of the HEPs included in the analysis is available from the author on request.

[16]Before 2000, some small countries were not individually coded. The country of birth code I obtained from the DEST has a total of 95 countries and regions coded. The list of countries and regions are available from the author upon request.

[17]The Group of Eight (Go8) is a coalition of leading Australian universities, intensive in research and comprehensive in general and professional education.

[18]If each HEP gets an equal share of foreign students from different sending countries, i.e.,$\eta_{i,j} = \eta$, then there will be no variation in the predicted foreign enrollment across institution in a given

are small compared to the demand from the listed student sending countries. Note that, Table1.2 is only a part of the historical HEP share distributions for all the countries and regions (available on request).

Figure 1.4 and Figure 1.5 show the number of foreign students by the top sending countries during the sample period. The number of students from China and India has been increasing throughout the 7 years. The number of students from Singapore decreased from 2002 to 2005 and the number of students from Hong Kong decreased from 2003 to 2006. Overall, across countries, there is variation in the number of students not only in level but also in growth, and within a given country, there is typically no fixed trend (Graphs of other countries are available upon request).

1.3.4 Results

Native enrollment and foreign enrollment at the HEP level

Table 1.3 presents the OLS and IV estimates of the relationship between foreign enrollment and Australian native enrollment at the institution level. The specification is a variant of the system of equations in (1.18). The dependent variable is native enrollment. The fourth column includes HEP fixed effects, HEP fixed trends, and the year fixed effects. The third column excludes institution fixed trends, the second column excludes year fixed effects, and the first column includes only HEP fixed effects. The first-stage F-statistics for the instrumental variable from column (1) to column (4) are 59, 72, 19, and 25. The errors are clustered by HEP to adjust for potential serial correlation.

The IV estimates (top row) are positive and are not statistically different. The point estimates in column (3) and in column (4) are 0.73 and 0.75, indicating that the impact identified with demand-induced growth in foreign enrollment within a HEP is very similar to the impact identified with demand-induced deviation around the HEP fixed trend. A comparison of the point estimates in column

year. All the variation in foreign students will be across year and will be sucked up by the year-fixed effects.

(2) and column (4) tells us a slightly different story. Though not statistically different, omitting year fixed effects increases the point estimate from 0.75 to 1.15, which is a more than 50% increase. We cannot say for sure if the difference is just because of imprecision in estimation due to the big standard error. If it is not, then the increase suggests that the years when a HEP has a higher than fixed trend increase in foreign enrollment are those when it has a higher than fixed trend increase in native enrollment for other reasons. These year-specific factors, as I discussed earlier in the paper, may be global common factors in demand for higher education, or innovations in the Australian higher education sector that reduce the marginal enrollment costs inducing an increase in the supply to both native and foreign students.

The bottom row in Table 1.3 depicts the corresponding OLS estimates. The OLS estimates are all smaller than the IV estimates. Due to the big standard error in the IV estimates, the 95% confidence intervals of the IV estimates and the OLS estimates overlap. However, all the IV estimates are outside the 95% confidence interval of the OLS estimates. The difference between OLS and IV estimates suggests that HEPs become more active in serving foreign students when their ability to serve domestic students is low. This is consistent with the findings in the case study (Marginson and Eijkman, 2007) that attributes the growth in foreign students to the decline of per capita public funding.

The preferred estimate is based on the stringent identification strategy in column (4). Even though the point estimate is almost same as the one in column (3), the first-stage F-statistic is bigger with HEP-specific trends and leads to a smaller standard error. The identification comes from the deviation in the growth of native enrollment around each HEP's trend that is caused by demand-induced deviation around the trend in the growth of foreign enrollment. The interpretation of the estimated coefficient is that the enrollment of an additional foreign student in an Australian HEP will induce this HEP to enroll 0.75 more native students with a standard error of 0.29. From 2001 to 2007, native enrollment grew annually by $7,154$ on average in Australia. Foreign enrollment grew by $16,200$ on average each year. Thus, the estimated coefficient implies that the enrollment of foreign students can explain all the time trend in native enrollment over the 7 years and, given the realized public funding to higher education, native enrollment would have declined annually by $4,997$ on average had there been no increase in the number of foreign students in Australia.

Table 1.4 provides a check for the validity of the IV. With only one instrumental variable, I am not able to perform an over-identification test. However, I do check to see that the number of students by sending country on average is not correlated with the error in native enrollment. Specifically, I construct the instrumental variable using the HEP share distributions by country during the initial period and the total number of students studying abroad by country from 2001 to 2007, which I take from the UNESCO website.[19] The total number of students studying abroad reflects a country's aggregate demand for international education. On average, the trend should be correlated with the demand for Australian higher education. The advantage of this variable is that it is very unlikely to be correlated with unobserved errors in the native enrollment of Australian HEPs. In 2007, Australia was the third largest exporter of higher education and had 11% of the international higher education market. Each of the 39 Australian HEPs is small compared to the global market. The disadvantage of this variable is that it excludes useful variation in demand for Australian higher education generated by factors specific to the relationship between Australia and the sending countries (e.g., exchange rates and bilateral trade agreements).

Table 1.4 presents the estimates with the instrumental variable constructed with total number of students studying abroad (I call them "modified IV estimates"). Just as in Table 3, the specification is a variant of the system of equations in (1.18). The dependent variable is native enrollment. The columns have the same set of fixed effects, fixed trends, and year fixed effects as in Table 3. The first-stage F-statistics for the instrumental variable from column (1) to column

[19] The variable is one of the student mobility indicators and is titled "Students from a given country studying abroad (outbount mobile students)". This variable is not a number specific to higher education but should be a good proxy for a country's demand for overseas higher education. The UN data do not have statistics regarding Taiwan. The reported estimate treat Taiwan as missing. As a check, I use the number of Taiwan students in US to measure its demand for international higher education, and the estimate is not affected.

(4) are 29, 11, 27, and 10. Not surprisingly, they are smaller than the first-stage F-statistics using the IV constructed with the number of students in Australia. Including HEP-specific trends decreases the strength of the instrument. In this one endogenous variable one instrumental variable case, the first-stage F-statistics suggest that the instrumental variable is not weak even in the most stringent specification (Staiger and Stock, 1997). The modified IV estimates (the top row in Table 1.3) are very similar to the original IV estimates (top row in Table 1.2). The similarity of the two sets of estimates implies that, if we believe each Australian HEP is small in the international higher education market, we should also believe the number of students in Australia by country is not on average correlated with HEP- and year-specific errors in native enrollment.

Native enrollment and tuition revenue from foreign students

The first extension investigates the relationship between native enrollment and revenue from foreign students across HEPs, across time. The revenue from foreign students is treated as endogenous and instrumented with the predicted number of foreign students, using demand side variations as in the main analysis. Also, as a placebo test, I use the instrumental variable to predict the grants from the Commonwealth Government Financial Assistance.[20] This analysis offers a more intuitive way to understand the native enrollment gain and also serves as a test for the identification strategy.

The revenue data are taken from the Finance Collection and the Research Expenditure Collection by DEST for the years 2001 to 2007 and measured in 1,000 constant (2000) Australian dollars. The final sample has 34 HEPs that report the student enrollment and finance data every year during the sample period.

Let REV_{it}^{g} denote the revenue from Commonwealth Government Financial Assistance (CGFA) and REV_{it}^{f} be the revenue from tuition fees from foreign students. In the first stage, I regress REV_{it}^{g} and REV_{it}^{f} on the instrumental variable

[20] This is the block grants that HEPs receive from the Commonwealth Government, which does not include the revenue from the Higher Education Contribution Scheme (HECS). The revenue from HECS is an increasing function of native enrollment.

$\widehat{S}_{f,it}$ as follows

$$y_{it} = \zeta + \varphi_{1i} + \varphi_{2i}t + \tau_1 \widehat{S}_{f,it} + \psi_t + \upsilon_{it} \tag{1.19}$$

where $y_{it} = \{REV_{it}^{g}, REV_{it}^{f}\}$, and φ_{1i} , φ_{2i} are HEP fixed effects and fixed trends; and ψ_t are year fixed effects. υ_{it} are the unobserved HEP- and year-specific errors.

Table 1.5 reports how the revenue from CGFA and tuition revenue from foreign students respond to demand-driven variations in foreign students. The dependent variable in column (1) to (3) is tuition revenue from foreign students. Column (1) includes only HEP-fixed effects, column (2) adds year-fixed effects, and column (3) adds HEP-fixed trends. The dependent variable in columns (4) to (6) is the revenue from CGFA. The impact on tuition from foreign students is significantly positive in all specifications, which confirms the relevance of the instrument. On the other hand, revenue from the CGFA does not vary with the predicted foreign enrollment in any of the specifications except the one wherein year-specific factors are controlled for and the instrument is constructed with the number of students in Australia by sending country.[21] The results show that the impact of foreign enrollment is not falsely identified by some spurious correlation between public funding and the demand driven variation in foreign enrollment.

Table 1.6 presents the IV estimates of the relationship between native enrollment and the tuition revenue from foreign students. The dependent variable is the number of native students. The tuition revenue from foreign students is treated as endogenous. The instrumental variable is the one constructed with the number of students in Australia.[22] The specification is a variant of the following system of equations

$$REV_{it}^{f} = \zeta + \varphi_{1i} + \varphi_{2i}t + \tau_1 \widehat{S}_{f,it} + \psi_t + \upsilon_{it} \tag{1.20}$$
$$S_{it} = \iota + \xi_{1i} + \xi_{2i}t + \tau_2 REV_{it}^{f} + \omega REV_{it}^{g} + \vartheta_t + \mu_{it}$$

[21] This means that, once year-specific factors that common to all HEPs are controlled, within a HEP the change in Commonwealth funding is weakly correlated with the change in demand from foreign students over time.

[22] The instrumental variable constructed with the number of students studying abroad is significant in the first-stage regression as we can see from Table 1.5. However, it is not strong enough to give reliable second-stage estimates.

The estimated impact of tuition revenue from foreign students on native enrollment is positive. The preferred IV estimate is the one in column (6) that includes the revenue from the government, the HEP-fixed effects, the year fixed effects, and the HEP-fixed trends. The first-stage F-statistic is 12.6. The impact is identified from the deviation in the growth of native enrollment around each HEP's trend that are caused by demand-driven deviation around the trend in the growth of tuition revenue collected from foreign students. The interpretation of the estimated coefficient is that an increase of A$10,000 (constant 2000) in tuition revenue collected from foreign students by a HEP would lead to the enrollment of 0.8 more native students in this HEP. During the sample period, each foreign student brought $A\$7,929$ on average. The estimated impact of foreign students' revenue on native enrollment implies the enrollment of one more foreign student leads to the enrollment of about 0.63 more native students.

Native enrollment and foreign enrollment at the State level

The first extension explores whether we can extend the institution level evidence to a greater level of aggregation. According to the model, an increase in aggregate native enrollment in higher education is a sufficient condition for all native workers, not only those who otherwise would not be able to get higher education, to gain from the export of higher education. The institution level evidence can be extended to a greater level of aggregation only when the impact of foreign students on native enrollment does not spill over to other HEPs. If the increase in native enrollment at a HEP induced by the increase of foreign enrollment at this HEP is at the cost of an reduction in native enrollment at another HEP, then the positive HEP-level enrollment gains overstate the gains at a greater level of aggregation. On the other hand, if a HEP that collects significant revenue from foreign students bargains less aggressively with the government for public funding, then some other HEPs may get more funding (given the total funding allocated to higher education) and are thus able to enroll more native students. In this case, the institution level enrollment gains understate the aggregate enrollment gains. To check whether the spillover across HEPs is a problem, I relate native enrollment in a state in a given year to foreign enrollment in this state in the same year. Foreign enrollment is treated as endogenous and instrumented with demand-induced variation following a similar logic as in the HEP-level analysis. (Details in the Appendix). I find no evidence of spillover within a state: the enrollment of one more foreign student in a particular state increases this state's native enrollment by 0.89 with a standard error of 0.17.[23]

1.4 Conclusion

This paper shows how non-profit HEPs distribute the gains from exporting higher education to native workers through their utility maximizing behavior. The empirical investigation of Australian higher education finds that, had there been no increase in foreign students during the period 2001 to 2007, Australian native enrollment would have declined annually by about $5,000$ on average, instead of the $7,154$ annual growth. The evidence implies that modeling the higher education sector as a private and competitive industry leads to the misunderstanding of the impact of exporting higher education on native workers. It also suggests that the benefit Australian native workers receive from HEPs' quality improvement and enrollment subsidization dominates the cost associated with the inflow of foreign students.

The driving force for trade in higher education is the difference in the relative abundance of education inputs. However, only a limited number of education input abundant countries (the UK, Australia, and New Zealand) actively engage in the export of higher education by charging foreign students much higher fees than the subsidized native tuition and putting no quotas on the number of foreign students. The model and the empirical evidence have important policy implications for regions that have invested a lot in higher education in the past. Exporting

[23]This is the IV estimate from regressing native enrollment at state level on foreign enrollment with state fixed effects and year fixed effects. The first-stage F-statistics is 97. The identification is from the change in native enrollment within a state caused by the change in demand-driven foreign enrollment in this state. Including state-fixed time trends decreases the first-stage F-statistic to lower than 10.

higher education offers an alternative revenue source for HEPs and has the potential to benefit not only HEPs but also native workers.

The world's demand for international higher education could increase to 8 million in 2025 according to an Australian government report in 2005. HEPs in the US have great potential to gain from the international higher education market. Compared to Australia, the US is not very open in this area. As of 2007, foreign students account for 3.5% of US total higher education enrollment but 27% of Australian total higher education enrollment. While 13 Australian HEPs have foreign enrollment above 8,000, the top foreign-student-receiving institution in the US, University of Southern California, has 7,189 foreign students, and the top-foreign-student-receiving public institution, University of Illinois at Urbana-Champaign, has only 5,922 foreign students. Currently, some HEPs in the US face the same situation that Australian HEPs faced in 1996. States like California and Michigan have accumulated a lot of education inputs in their public universities, and have had significant declines in public funding to higher education in recent years. The Australian experience suggests that these states can use their comparative advantage in the higher education sector to recruit full-fee paying foreign students and help more native students gain access to higher education, which eventually benefits all workers.

1.5 Figures and Tables

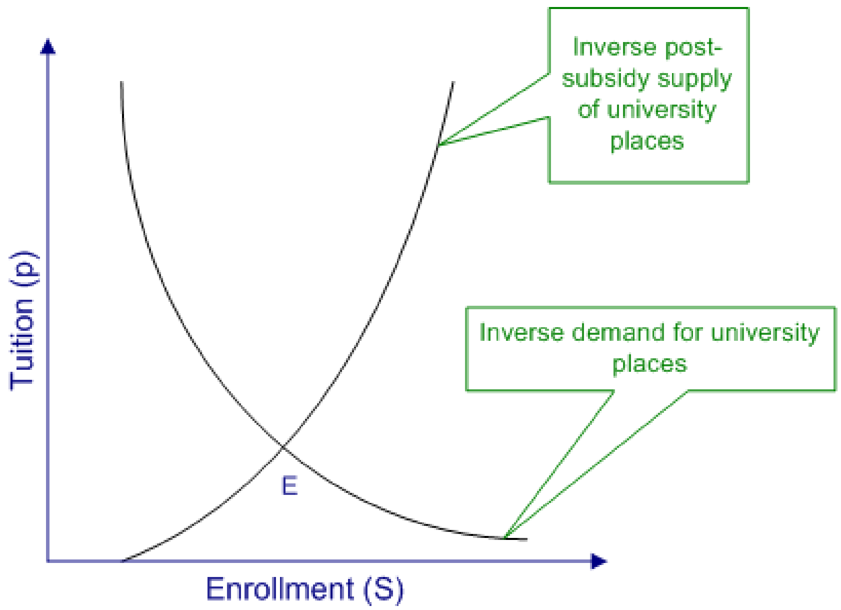

Figure 1.1: Equilibrium enrollment and tuition in a closed economy

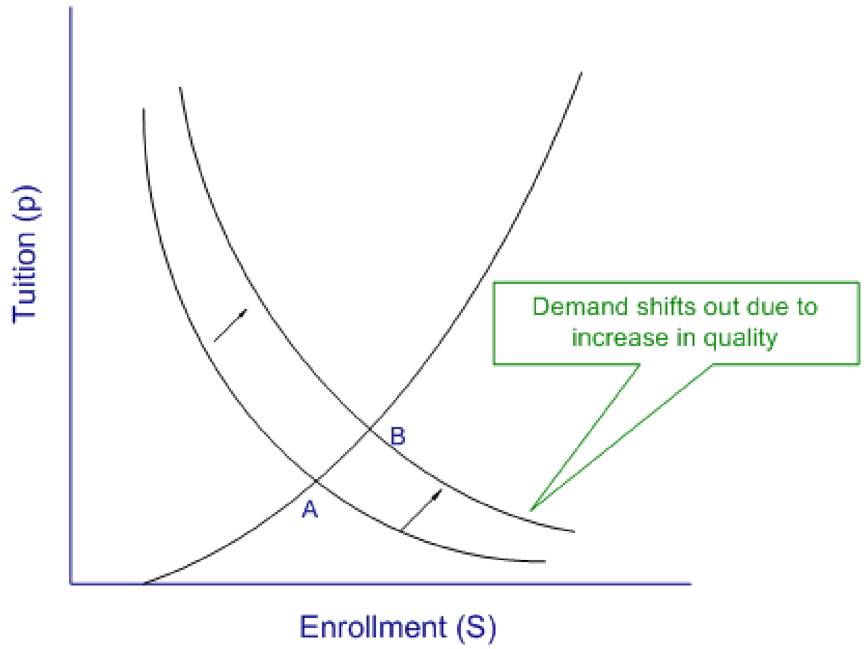

Figure 1.2: An increase in the education input K

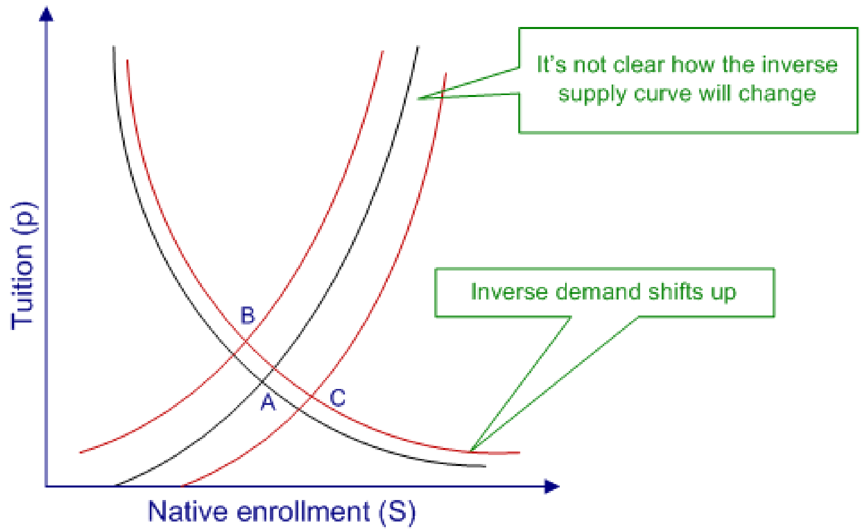

Figure 1.3: Impact of foreign students on native enrollment

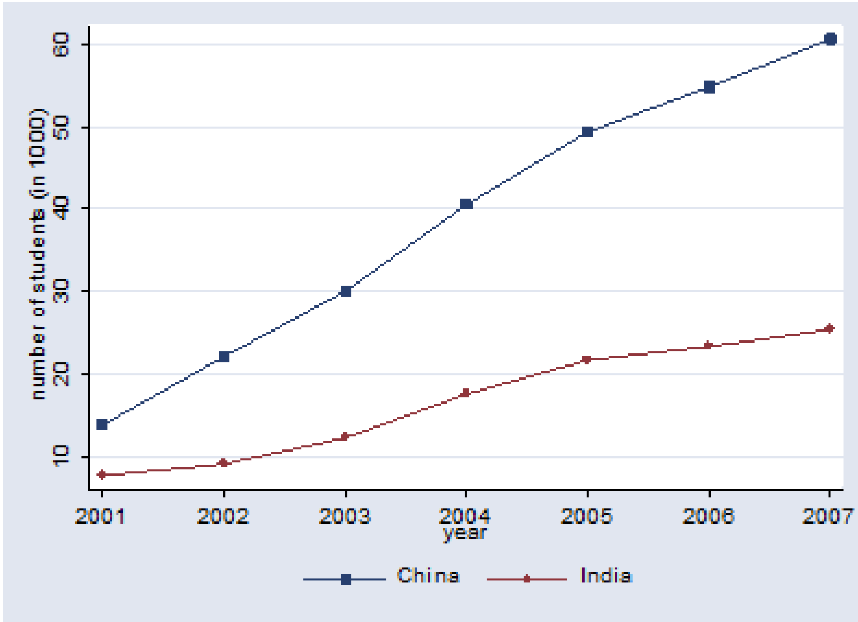

Figure 1.4: Number of students in Australia from China and India (2001 to 2007)

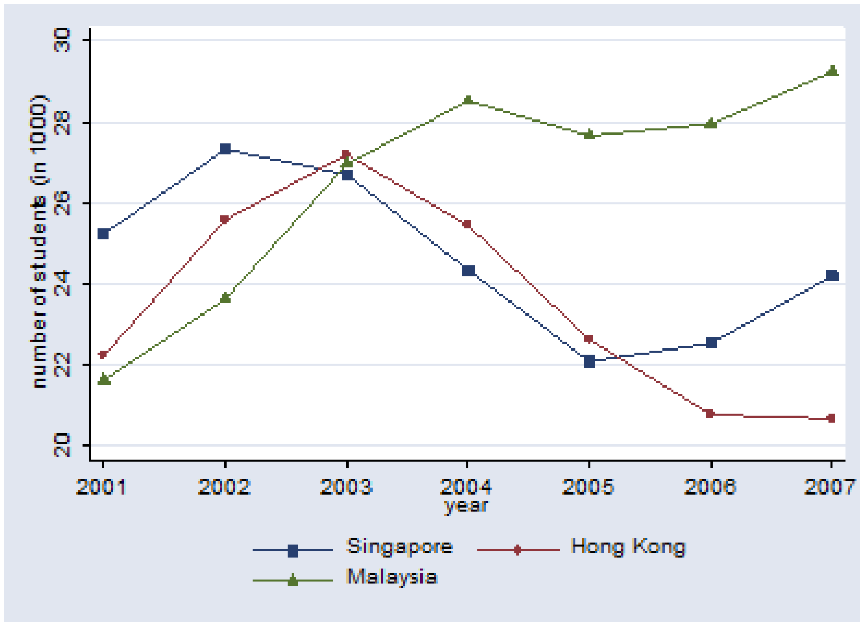

Figure 1.5: Number of students in Australia from Singapore, Hong Kong, and Malaysia (2001 to 2007)

Table 1.1: Comparative statics of the autarky equilibrium

	Resulting change in					
Change in parameter	R	q	p	S	W_u	W_h
Increase in K	0	+	+	+	+	-
Increase in g	+	+	?	+	+	-
Increase in N	0	0	+	+	-	+
Increase in β (σ)	+	+	+	?	?	?

Table 1.2: Historical share distribution for the top sending countries

	CHN	IND	INDNS	HK	MLS	SNGP	TWN	THLD	US	JPN	KR
Monash U.	5.2	2.4	4.7	10.8	5.5	8.5	5.1	3.2	1.0	5.6	3.5
Australian National U.	1.8	0.6	1.1	1.0	0.6	0.8	0.5	1.8	2.6	3.2	1.4
U. of Adelaide	0.9	0.9	1.0	0.4	1.6	0.3	0.1	0.9	1.6	0.9	1.2
U. of Melbourne	2.3	1.2	1.2	2.0	2.5	1.3	1.8	1.8	6.1	2.8	1.5
U. of New South Wales	5.9	4.0	6.4	5.3	3.1	1.8	5.1	4.7	10.8	2.2	8.7
U. of Queensland	1.6	0.9	1.4	0.8	0.8	0.7	1.7	3.9	4.0	3.3	1.0
U. of Sydney	3.1	1.6	1.0	2.1	0.9	1.3	3.2	1.8	4.9	5.1	3.9
U. of Western Australia	1.0	1.2	1.1	0.6	2.2	3.8	0.7	2.4	0.6	0.8	0.5
Total group 8	21.9	12.7	17.7	23	17.3	18.7	18.1	20.3	31.4	24.1	21.8

Note: Percents of students from top sending countries (listed in columns) at the Group of Eight universities (in rows), averaged over the period 1989 to 1994. The top student sending countries and regions are China, Hong Kong, India, Indonesia, Japan, Korea, Malaysia, Singapore, Taiwan, Thailand, and the US.

Table 1.3: Relationship between native students and foreign students in HEPs

	(1)	(2)	(3)	(4)
$S_{f,it}$	1.04***	1.15***	0.73**	0.75**
	(0.24)	(0.18)	(0.35)	(0.29)
HEP fixed effects	yes	yes	yes	yes
HEP fixed trends	No	yes	No	yes
Year fixed effects	No	No	yes	yes
First-stage F-statistics	59	72	19	25
n	273	273	273	273
	Ordinary least squares estimates			
$S_{f,it}$	0.46***	0.56***	0.23***	0.29**
	(0.10)	(0.17)	(0.08)	(0.13)

Notes: The specifications are based on instrumental variables estimation where the actual number of foreign students in a HEP is treated as endogenous. The dependent variable is the native enrollment in a HEP. The sample has 273 observations based on the 39 HEPs for the years 2001 - 2007. The standard errors are clustered by institution to adjust for potential serial correlation. *** indicates $p - value < 0.01$, ** indicates $p - value < 0.05$, and * indicates $p - value < 0.1$.

Table 1.4: A check for the validity using an IV using outbound mobility of students

	(1)	(2)	(3)	(4)
$S_{f,it}$	0.96***	1.08***	0.73**	0.85**
	(0.21)	(0.16)	(0.35)	(0.28)
HEP fixed effects	yes	yes	yes	yes
HEP fixed trends	no	yes	no	yes
Year fixed effects	no	no	yes	yes
First-stage F-statistics	29	27	11	10
n	273	273	273	273

Notes: The specifications are based on instrumental variables estimation where the actual number of foreign students in a HEP is treated as endogenous. The dependent variable is the native enrollment in a HEP. The sample has 273 observations based on the 39 HEPs for the years 2001 - 2007. The standard errors are clustered by institution to adjust for potential serial correlation. *** indicates $p - value < 0.01$, ** indicates $p - value < 0.05$, and * indicates $p - value < 0.1$.

Table 1.5: The relationship between revenue and demand-driven variation in foreign enrollment

	(1)	(2)	(3)	(4)	(5)	(6)
	REV_{it}^{f}			REV_{it}^{g}		
$\widehat{S}_{f,it}$ (predicted with students in Australia by country)	11.02***	11.18**	13.51***	0.62	6.07*	-14.40
	(2.93)	(3.73)	(3.81)	(2.34)	(3.20)	(9.94)
$\widehat{S}_{f,it}$ (predicted with students studying abroad by country)	1.16***	1.51***	1.22**	-0.54	0.61	-1.38
	(0.21)	(0.38)	(0.48)	(0.47)	(0.42)	(1.02)
HEP-fixed effects	yes	yes	yes	yes	yes	yes
HEP-fixed trends	no	no	yes	no	no	yes
Year fixed effects	no	yes	yes	no	yes	yes
n	238	238	238	238	238	238

Notes: The dependent variable in column (1) to (3) is tuition revenue collected from foreign students in 1,000 constant (2000) Australian dollar. The dependent variable in column (4) to (6) is revenue from Commonwealth Government Financial Assistance in 1,000 constant (2000) Australian dollar. The independent variable is the instrumental variable. The sample has 238 observations based on the 34 HEPs for the years 2001 - 2007. The standard errors are clustered by institution to adjust for potential serial correlation. *** indicates $p - value < 0.01$, ** indicates $p - value < 0.05$, and * indicates $p - value < 0.1$.

Table 1.6: The relationship between native enrollment and tuition revenue from foreign students

	(1)	(2)	(3)	(4)	(5)	(6)
REV_{it}^{f}	0.13***	0.13***	0.06*	0.07*	0.09***	0.08**
	(0.04)	(0.04)	(0.04)	(0.04)	(0.03)	(0.03)
REV_{it}^{g}		-0.017**		-0.007		-0.005
		(0.008)		(0.004)		(0.003)
HEP-fixed effects	yes	yes	yes	yes	yes	yes
HEP-fixed trends	no	no	no	no	yes	yes
year-fixed effects	no	no	yes	yes	yes	yes
First-stage F-statistics	14.2	14.2	9	9	12.6	12.6
n	238	238	238	238	238	238

Notes: The specifications are based on instrumental variables estimation where the revenue collected from foreign students (in 1,000 constant 2000 Australian dollars) is treated as endogenous. The dependent variable is the native enrollment. The sample has 238 observations based on the 34 HEPs for the years 2001 - 2007. The standard errors are clustered by institution to adjust for potential serial correlation. *** indicates $p - value < 0.01$, ** indicates $p - value < 0.05$, and * indicates $p - value < 0.1$.

1.6 Appendix

1.6.1 Existence and uniqueness of the autarky equilibrium

Following is proof that equation (1.8) identifies a unique $S \in (0, \frac{N}{n}\alpha$[24]$]$. I do this by showing that the left-hand side of equation (1.8) is a monotone increasing function of S from negative infinity to $c - \frac{(1-\sigma)g}{1-(1-\beta)\sigma}\frac{n}{N\alpha} > 0$ and the right-hand side is a monotone decreasing function of S from positive infinity to 0.

Denote the left-hand side of (1.8) as $LHS = c - \frac{(1-\sigma)g}{1-(1-\beta)\sigma}\frac{1}{S}$. We see that $\lim_{S\to 0} LHS = -\infty$. Differentiate LHS with respect to S, we get

$$\frac{\partial LHS}{\partial S} = \frac{\partial c}{\partial S} + \frac{(1-\sigma)g}{1-(1-\beta)\sigma}\frac{1}{S^2}$$

Assuming the marginal enrollment cost function is non-decreasing in S, i.e., $\frac{\partial c}{\partial S} \geqslant 0$, we get $\frac{\partial LHS}{\partial S} > 0$. I assume, when S equals the number of students that makes the wage gap between educated and uneducated worker to be zero, the public funding per student is less than the marginal enrollment costs, i.e., $c - \frac{(1-\sigma)g}{1-(1-\beta)\sigma}\frac{n}{N\alpha} > 0$.

The right-hand side of (1.8) is the tuition p, or equation (1.7). We wee that $\lim_{S\to 0} p = \infty$ and when $S = \frac{N}{n}\alpha$, $p = 0$. By differentiating equation (1.7) with respect to S, we get

$$\frac{\partial p}{\partial S} = \frac{\alpha(\alpha-1)nN^2(1-\theta)^\alpha q^\alpha}{(N-nS)^3}\left(\frac{nS}{N-nS}\right)^{\alpha-2} < 0$$

Therefore, there must be a unique $S \in (0, \frac{N}{n}\alpha]$ such that equation (1.8) holds.

1.6.2 Comparative statics of the autarky equilibrium

An increase in β, the return to investment in quality, makes the HEPs devote a bigger portion of revenue to improve quality and leads to a higher education quality. The quality increase shifts out the inverse demand for higher education

[24] $p = 0$ when $S = \frac{N}{n}\alpha$. Here the assumption is tuition is non-negative.

places. On the other hand, HEPs devote a smaller portion of revenue to subsidize student enrollment, so the inverse post-subsidy supply shifts up as well. The increase in demand and decrease in supply drive up the tuition, but enrollment may increase or decrease.

An increase in g, the public funding to each HEP, increases both the investment in quality improvement and the subsidy to students. So, the inverse demand shifts out because of the higher quality, and the post-subsidy supply of higher education places shifts down. The equilibrium student enrollment will increase, but the equilibrium tuition can increase or decrease. The aggregate level of human capital H increases because both education quality q and the number of skilled workers nS increase. The marginal value of human capital increases, and the marginal value of unskilled worker increases. All workers are better off.[25]

An increase in N, the population, increases the amount of unskilled labor L_u, which increases the return to investing in human capital and decreases the opportunity cost of getting educated. The demand for higher education will increase. With no change on the supply side, the equilibrium enrollment and tuition will increase even though the investment in quality improvement and the quality do not change. The marginal value of unskilled labor decreases and the marginal value of human capital increases. All workers are worse off.

1.6.3 Existence and uniqueness of the trade equilibrium

Following is a proof that there exists a unique $\{S_f, S, S^*\}$ that determines the trade equilibrium. I do so by showing that, for any given S_f, there exists a unique S^* and S that satisfy equation (1.11) and equation (1.14). Then I will show that there exists a unique S_f that satisfy equation (1.15).

As shown in the proof of autarky equilibrium, the left hand side of equation (1.11) is a monotone decreasing function of S^* from negative infinity to a positive

[25]This analysis shows that an increase in g leads to an increase of income per worker. However, an increase in g is not costless. It either means an increase in tax or a reduction of other public spending. The question of optimal g is not in the scope of this analysis. In general, it is determined when the marginal benefit of g equals the marginal cost of g.

number. The right hand side of equation (1.11) is the tuition in Foreign, p^*. For any given S_f, assume $p^*(S^* = 0) > 0$, which means that importing higher education will not eliminating the higher education sector in the Foreign country. We differentiate p^* with respect to S^*, and we get

$$\frac{\partial p^*}{\partial S^*} = \alpha(\alpha - 1)n(1-\theta)^2(\frac{H^*}{L_u^*})^{\alpha-2}\frac{[Nq^* + nS_f(q - q^*)]^2}{L_u^{*3}} < 0$$

Therefore, equation (1.11) identifies a unique S^* for any given S_f.

As shown in the proof of autarky equilibrium, for any given $S_{f,}$ the right hand side of equation (1.14) is a monotone decreasing function of S from positive infinity to zero. The left hand side of equation (1.14) is the post-subsidy marginal cost of enrollment (denoted by PMC). We see that $\lim_{S\to 0} PMC = -\infty$. Differentiate PMC with respect to S, we get

$$\frac{\partial PMC}{\partial S} = n\frac{\partial c}{\partial S} + \frac{(1-\sigma)(g + \pi S_f)}{1-(1-\beta)\sigma}\frac{1}{S^2} > 0$$

I assume that, when S equals the number of students that makes the wage gap between educated and uneducated workers to be zero, the public funding per student is less than the marginal enrollment costs. Therefore, equation (1.14) identifies a unique S for any given S_f.

To show a solution exists and is unique, I then need to show that a unique solution exists for S_f. Or equation (1.15) identifies a unique S_f. The left hand side of equation (1.15) is $p_f = c(nS, nS_f) + \pi$. The right hand side of equation (1.15) is $\widetilde{p}_f$. When $S_f = 0$, $p_f = c(nS^a) + \pi$ is assumed to be less than $\widetilde{p}_f$ for trade to occur. Differentiate p_f with respect to S_f, we get

$$\frac{\partial p_f}{\partial S_f} = nc^{'}(\frac{\partial S}{\partial S_f} + 1) > 0$$

The left hand side of equation (1.15) is a monotone increasing function in S_f.

Next I will show that there exists a $\widehat{S}_f$ such that for $S_f \geq \widehat{S}_f$, $\widetilde{p}_f$ is monotone decreasing function in S_f. Let's first look at

$$\frac{\partial \widetilde{p}_f}{\partial q}\frac{\partial q}{\partial S_f} = \alpha\,(1-\theta)^{\alpha}\left(\frac{nqS_f + nq^*S^*}{N - nS^* - nS_f}\right)^{\alpha-1}$$
$$[1-(1-\alpha)(1-\frac{nq^*S^*}{nqS_f+nq^*S^*}+\frac{nS_f}{N-nS^*-nS_f})]\frac{\partial q}{\partial S_f}$$

Define $\Delta = 1-(1-\alpha)(1-\frac{nq^*S^*}{nqS_f+nq^*S^*}+\frac{nS_f}{N-nS^*-nS_f})$. $\lim_{S_f\to\frac{N}{n}-S^*}\Delta = -\infty$ and $\frac{\partial\Delta}{\partial S_f} < 0$. Since the rest of the impact of S_f on $\widetilde{p}_f$ is always negative, there must be a $\widehat{S}_f$ such that for $S_f \geq \widehat{S}_f$, $\widetilde{p}_f$ is monotone decreasing function in S_f. Therefore, equation (1.15) identifies a unique S_f.

1.6.4 Instrument for foreign enrollment at the state level

To construct an instrumental variable for foreign enrolment at state level using the demand side variation, we need the state share distribution by sending country during the period 1989 to 1994 and a measure of demand for Australian higher education by sending country over the period 2001 to 2007.

Let us first think about the relation between the historical state share distributions and the historical HEP share distributions. The state share is the HEP share summed over the number of HEPs in the state. Because both the shares and number of HEPs are taken from the short period after Australia opened the higher education sector, it is very unlikely that the state foresaw the huge gain from exporting higher education and strategically built the universities. With a belief that the state shares are determined by the networks of foreign students in HEPs and the historical geographic distribution of HEPs, they should be independent of the state- and year-specific errors in native enrollment.

However, the state shares are naturally much bigger than the institution shares. States like Victoria and New South Wales are big enough to affect the total number of students from every country, including countries like China and India. It is very unlikely that the numbers of foreign students in Australia by sending country on average are not correlated with errors in native enrollment at the state level. To overcome this problem, I use the total number of students a country sends to the whole world to construct the instrument. This number reflects a country's demand for oversea higher education and therefore should be correlated with its demand for Australian higher education. However, as long as individual Australian states are small relative to the total international education market, the number should be independent of errors in native enrollment at state level.

Chapter 2

The economics of commercial development in low-income communities

2.1 Introduction

Commercial revitalization is a popular strategy in implementing the federal urban Empowerment Zones program. Local governments argue that, besides the job creation motive, they choose this strategy because low-come communities are "under-served" with commercial goods and services. According to the estimate in *New Markets: The Untapped Retail Buying Power in America's Inner Cities* (U.S. Department of Housing and Urban Development [HUD], 1999), the U.S. inner-city neighborhoods had an unmet demand of $8.7 billion. A natural question to ask is whether the supply side will respond to this shortage. If the unmet demand is a temporary thing that happens during the market adjustment process, then the government does not need to worry much. If, however, stores do not enter these communities and the shortage is persistent, then we need know why the commercial market fails in these communities, and what the government can do to solve the under-provision problem.

This paper presents a model of commercial development that relates economic agglomeration of goods and services to the income level of a community, and shows that it is harder for the commercial market to achieve necessary economic agglomeration in low-income communities. In this model, commercial agglomeration is the result of consumers' preference for different varieties of goods and services, captured by a CES utility function, and the transportation costs associated with traveling to the physical place where the varieties are provided. Consumers are more likely to incur the transportation costs to shop at a place where more varieties are available. Commercial goods and services that agglomerate at the same location generate positive demand externalities for each other: more varieties attract more consumers and lead to higher revenue. With fixed costs in commercial provision (e.g., rent paid to the landlord), an agglomeration threshold has to be achieved for each variety to break even. If there is no mechanism to achieve the agglomeration threshold, the commercial market may stuck at an equilibrium with under-provision even though there exists an efficient equilibrium.[1]

The existence of a more efficient equilibrium creates an opportunity for private agents who have the potential to achieve the agglomeration threshold. The commercial development model in today's market often involves developers and big stores – a developer is the leader of a project and the owner of the commercial center, and big stores are anchor tenants. This arrangement creates a synergy and is beneficial to both parties. Without the developer, a big store will have no tool to charge nearby specialized stores for the positive demand externalities. Most likely, owners of the properties that the specialized stores occupy will get all the benefits through either an increase in rents or property value.[2] A developer, through lease contracts with all the stores, will be able to internalize the externalities within the shopping center. However, the developer cannot start the project without anchor tenants, the big stores. According to the Urban Land Institution's (ULI) *Retail Development Handbook* (RDH), "as a rule, a shopping center will not be built until the developer has secured commitments from key or anchor tenants" (page

[1]It is well-established in the literature (e.g., Krugman 1991, Rauch 1993) that the presence of economic agglomeration leads to the existence of multiple equilibria.

[2]This happens if there are more potential small commercial business owners than the spaces that are close enough to benefit from the big store's consumer base.

91) and “the loss of an anchor or major tenants can break a retail project” (page 126).[3] Anchor tenants, aware of their importance in commercial development and their negotiation strength, can grab a share of the payoff. Evidence shows that anchor tenants usually pay much lower rents than small tenants. According to the estimate of Pashigian and Gould (1998), anchor stores receive a per foot rent subsidy of no less than 72 percent of the rent that non-anchor stores pay. In Gould, Pashigian and Prendergast (2005), they state that “the most striking feature of anchor contracts is that most anchors either do not pay any rent or pay only a trivial amount”.

It may be reasonable to assume that once enough shopping spaces are committed by the anchor tenants, the developer can costlessly lease the rest of the commercial spaces to specialized stores. The developer can let potential small commercial business owners bid for a slot in the shopping center and extract all the profits from them.[4] However, a developer has to incur non-negligible costs before the negotiation with anchor tenants. A developer has to do a market analysis, a site suitability analysis, and a regulatory review before they search for anchor tenants that are right for the project. The search process can be costly both in terms of time and money. Big stores usually have their own expansion plans and market targets. For instance, before approaching the owner of the Hue-Man bookstore, the developer of Harlem USA had been turned down first by Barnes & Noble then by Borders. During the process of developing East River Plaza, the Blumenfeld Development Group (BDG) took years to convince Home Depot to be its anchor tenants. The leases were redone twice and Home Depot finally decided not to open the store due to the slowdown of its national expansion plan. At the point of negotiation, the anchor tenants have no incentive to share the costs that are sunk to the developer. When a developer considers whether or not to initiate a

[3]The importance of anchor tenants to commertial development is a result of the need for economic agglomeration and significant coordination costs. Recruiting small businesses to achieve the necessary economic agglomeration may be a worse option because coordination costs are too high.

[4]“For a retail center with major tenants, smaller tenants represent the largest income potential for the project. Although major tenants may be the primary generator of customer traffic and the financial foundation for attracting initial capital commitments, inline shops pay higher rents and generate the greatest profits for the developer.” (Retail Development Handbook [page 127])

project, he must anticipate sharing the payoff with the anchor tenants, but bearing the pre-negotiation costs alone. Therefore, a commercial project of which the total profit is positive may be not profitable for the developer. This kind of situation is more likely to happen in low-income communities where the total profit of a commercial project is slim to start with.[5]

Providing incentives directly to developers, either in the form of block grants, low-interest loans, or accelerated deductions, can overcome the commercial market failure in low-income communities. This policy intervention will create a total profit bigger than the cost to the government. Beyond that, residents of these communities benefit from having more employment and shopping opportunities close to where they live. The model shows that commercial revitalization benefits to developers is welfare enhancing for low-income communities, and suggests that policymakers should consider renewing the "commercial revitalization deductions" to commercial developers who invest in federal Renewal Communities.

The model also shows that employment tax abatements alone are much less effective than direct incentives to developers. It is very likely that in some low-income communities, employment tax abatements alone are not big enough to make a project profitable for the developer. If in some communities, they do push the developer into action, they will make the developer over-supply shopping spaces and the government loses tax revenue to anchor tenants as well. While the analysis is based on commercial development, its policy implication is more general: if lack of economic agglomeration is the problem with low-income communities, general tax abatements alone may not be effective in stimulating private investments in these communities or in achieving sustainable economic development. The current budgetary situation combined with the non-satisfactory performance of state Enterprise Zones has put the continuation of spatially targeted economic development programs in question. I argue that policymakers should ask what kind of strategies work, not the programs should be continued.

[5]This is a typical holdup problem that arises when one party must pay the cost while others share in the payoff. Proposed market solutions usually requires the agents to take actions (e.g., forming joint ventures) before incuring the costs. However, in the case of retail development, the costs must be sunk before the developer meets the anchor tenants.

The rest of the paper is organized as follows. Section 2 presents the model settings regarding consumption and provision of commercial goods and services. Section 3 discusses the organization of the commercial development market and the potential under-provision in low-income communities. Section 4 investigates how government policies affect commercial development in low-income communities. Section 5 concludes.

2.2 A model of commercial development

2.2.1 Consumption of commercial goods and services

Consumers are uniformly distributed along the circumference of a unit circle. All the consumers live along the same circle belong to the same community, have the same disposable income m, and have identical CES preference for different varieties of commercial goods and services. To consumer any of these goods and services, consumers have to costly travel to the physical place where the varieties are offered.

Outside of the community there is a shopping center that provides n_o varieties of goods and services (I will refer to as "the outside shopping center (OSC)"). Consumers have to incur transportation costs t_o if they choose to patronize this shopping center. If there is a shopping center in the community (I will refer to it as "the community shopping center (CSC)"), we can take the location of the CSC and cut the community into two identical semicircles. We can index consumers on the same semicircle by their distance z to the CSC. Assume that consumer z's transportation costs t to the CSC is an increasing function of z, i.e., $t'(z) > 0$ and that the CSC provides n varieties of goods and services. The prices of variety j provided by the OSC and the CSC are $p(j)_o$ and $p(j)_c$ respectively. Consumers will patronize the outside shopping center if their community does not have its own shopping center.

Assumption 1)

a) $n_o \geqslant n$*, which means that the OSC offers weakly more varieties of goods* *and services than the CSC.*

b) $p(j)_o = p(j)_c = p(j)$*, which means that no price difference for a variety that is provided by both the OSC and the CSC.*

The assumption implies that consumers who visit the OSC have no incentive to make another trip to the CSC because they can buy all the varieties that the CSC provides at the OSC at the same price. Therefore, no consumer will patronize both the OSC and the CSC.

Suppose consumers have full information on the location of the shopping centers and the availability and the priced of the varieties provided in each shopping center. The decision of consumers has two stages: First, consumers decide which shopping center they visit; Second, they choose the quantity of each variety of goods and service at the shopping center they visit. We will solve the consumers' problem use backward induction.

If consumer z patronizes the community shopping center, his or her maximization problem is given as

$$\underset{q(j,z)}{Max}\left[\int_0^n q(j,z)^{(\sigma-1)/\sigma}dj\right]^{\sigma/\sigma-1} \quad s.t. \int_0^n q(j,z)p(j)dj + t(z) \leqslant m$$

where $p(j)_c$ is the price of variety j at the community shopping center, $n \in [0,1]$ is the number of varieties, and $\sigma > 1$ is the elasticity of substitution among the varieties. The larger the σ, the closer substitutes the varieties are. In other words, a larger σ means a weaker consumer preference for variety. $q(j,z)$ is consumer z's demand for variety j provided at the community shopping center. From the first order conditions of consumer z's utility maximization problem, we get

$$q(j,z) = [m - t(z)]\, p(j)^{-\sigma} P(n)^{\sigma-1}$$

where $P(n) = \left[\int_0^n p(j)_c^{1-\sigma}dj\right]^{\frac{1}{1-\sigma}}$. Consumer z's utility from patronizing the community shopping center is $U(z) = \frac{m-t(z)}{P(n)}$.

The utility that consumers get from patronizing the outside shopping center is

$$U_o = \frac{m - t_o}{P(n_o)}$$

where $P(n_o) = \left[\int_0^{n_o} p(j)_o^{1-\sigma} dj \right]^{\frac{1}{1-\sigma}}$.

Consumer z will choose the community shopping center if $U(z) \geqslant U_o$. Let z^* be the consumer who is indifferent between patronizing the community shopping center and the outside shopping center, i.e., $U(z^*) = U_o$, then

$$z^* = t^{-1} \left[m - \frac{P(n)}{P(n_o)}(m - t_o) \right].$$

Consumer $z \in [0, z^*]$ will patronize the CSC and consumer $z \in [z^*, 1/2]$ will patronize the OSC.

We get the aggregate demand for variety j provided in the CSC of a semicircle by integrating individual consumer's demand for this variety over the interval $[0, z^*]$. Because a community has two identical semicircles, the aggregate demand for variety j is

$$Q(j) = 2 \int_0^{z^*} q(j, z) dz$$

2.2.2 Provision of commercial goods and services

The provision of variety j needs one unit of land and a fixed labor input $\alpha(j)$ as the fixed inputs. Each unit of j need $\beta(j)$ units of labor to produce. Assume a SC is a small portion of the whole economy, so labor is supplied competitively at w and land is supplied competitively at r. The profit function of variety j that is provided in a CSC with n variety is

$$\Pi(j) = Q(j)[p(j) - \beta(j)w] - \alpha(j)w - r$$

where $Q(j) = 2 \int_0^{z^*} q(z, j)dz = 2 \int_0^{z^*} [m - t(z)]p(j)^{-\sigma} P(n)^{\sigma - 1} dz$.

The supplier of variety j takes $P(n)$ and $P(n_o)$ as given and chooses $p(j)$ to maximize its profit. The first order condition of the profit-maximizing problem yields the price of variety j as

$$p(j) = \frac{\sigma}{\sigma - 1}\beta(j)w$$

Assume the provision of the varieties is symmetric in both the OSC and the CSC, then $p(j) = p = \frac{\sigma}{\sigma-1}\beta w$ and

$$P(n) = n^{\frac{1}{1-\sigma}} p P(n_o) = n_o^{\frac{1}{1-\sigma}} p.$$

Without loss of generality, I will make the following assumptions.

Assumption 2)

a) $n_o = 1$, which means that the OSC provides all the varieties of goods and services, i.e., it is fully developed.

c) $t(z) = tz$ and $t > 0$, which means that transportation costs to the CSC is linear increasing in consumers' distance to the CSC.

Under assumption 2), if $n < (\frac{m-t_o}{m})^{\sigma-1}$, $z^* = 0$; if $n \in [(\frac{m-t_o}{m})^{\sigma-1}, 1]$, the marginal consumer is

$$z^* = \frac{m - n_c^{\frac{1}{1-\sigma}}(m - t_o)}{t}$$

consumer z's ($z \leq z^*$) demand for each variety provided at the CSC is

$$q(z) = \frac{m - tz}{np}.$$

The aggregate demand for each variety is

$$Q = \frac{2mz^* - tz^{*2}}{np},$$

and the profit of each variety provided at the CSC is

$$\Pi = \frac{2mz^* - tz^{*2}}{\sigma n} - \alpha w - r.$$

Therefore, the relationship between Π and the number of varieties provided at the CSC n is

$$\Pi = \begin{cases} -\alpha w - r, & n < (\frac{m-t_o}{m})^{\sigma-1} \\ \frac{m^2 - n_c^{\frac{2}{1-\sigma}}(m-t_o)^2}{t\sigma n} - \alpha w - r, & n \in [(\frac{m-t_o}{m})^{\sigma-1}, 1] \end{cases}$$

2.2.3 Economic agglomeration of commercial goods and services

We can see the importance of economic agglomeration of commercial goods and services on the profitability of each varieties from the relationship between Π and n. No consumer would want to patronize a CSC if the number of varieties available at the CSC is smaller than $(\frac{m-t_o}{m})^{\sigma-1}$. It

Proposition 3. *If* $m \leq \frac{t_o}{1-\left(\frac{\sigma-1}{1+\sigma}\right)^{\frac{1}{2}}}$, *there exists an* $n^* = \left(\frac{m-t_o}{m}\right)^{\sigma-1}\left(\frac{1+\sigma}{\sigma-1}\right)^{\frac{\sigma-1}{2}} \in [(\frac{m-t_o}{m})^{\sigma-1}, 1]$ *that maximizes* Π. *If* $m > \frac{t_o}{1-\left(\frac{\sigma-1}{1+\sigma}\right)^{\frac{1}{2}}}$, $n^* = 1$ *maximizes* Π.

The proof is in the appendix. Proposition 3 states that there is a unique number of varieties n^* that maximizes the profit of each variety. Corollary 1, which follows from Proposition 3, describes the economic agglomeration of commercial goods and services: when varieties of goods and services agglomerate in the same CSC, the profit of each variety increases.

Corollary 1 *For* $n \in [(\frac{m-t_o}{m})^{\sigma-1}, n^*), \frac{\partial \Pi}{\partial n} > 0$.

2.3 Community income, coordination, and market equilibrium

When the number of varieties is optimally chosen, the profit of each variety is

$$\Pi(n^*; w, r, m) = \begin{cases} \frac{2m^{\sigma+1}(m-t_o)^{1-\sigma}}{t\sigma(\sigma-1)^{\frac{1-\sigma}{2}}(1+\sigma)^{\frac{1+\sigma}{2}}} - \alpha w - r, & m \leq \frac{t_o}{1-\left(\frac{\sigma-1}{1+\sigma}\right)^{\frac{1}{2}}} \\ \frac{m^2-(m-t_o)^2}{t\sigma} - \alpha w - r, & m > \frac{t_o}{1-\left(\frac{\sigma-1}{1+\sigma}\right)^{\frac{1}{2}}} \end{cases}$$

Proposition 4. $\Pi(n^*; w, r, m)$ *increases with the consumer income* m *under the condition* $\sigma < 2\frac{m}{t_o} - 1$.

The proof is in the appendix. Proposition 4 shows that as long as consumers' preference for varieties is not too weak (σ is too big), the maximum profit per variety at a CSC increases with the income level of this community.

Proposition 5. *If* $\Pi(n^*; w, r, m) < 0$*, the unique Nash equilibrium is* $n = 0$*.*

Proof. If $\Pi(n^*; w, r, m) < 0$, then not entering this community is the dominant strategy. □

Proposition 5 states that if each variety of goods and services lose money even if the CSC provides the optimal number of varieties, then the only Nash equilibrium is no shopping center for this community. Let m_1 be the community income level such that $\Pi(n^*; w, r, m_1) = 0$. If a community has no shopping center because its income level $m < m_1$, we do not consider this community under-served with commercial goods and services. If this community builds a SC with support from the government, it will not be able to sustain the shopping center without public subsidy because $\Pi(n^*; w, r, m) < 0$.

We will focus our attention on communities that have $m \geqslant m_1$ yet have no CSCs. Corollary 2, which follows Corollary 1, identifies the minimum number of varieties for a CSC in order for each variety to break even.

Corollary 2 *Assume* $m \geqslant m_1$*, there exists an* $n^0 \in [(\frac{m-t_o}{m})^{\sigma-1},\ n^*]$ *such that* $\Pi(n^0; w, r, m) = 0$*.*

If a community can not successfully have n^0 varieties agglomerate in the same place, then no variety will want to enter this community and no SC will be built. n^0 is therefore called "the agglomeration threshold" of a CSC.

The rest of this section considers three different market structures: 1) with only symmetric specialized firms, 2) with multi-variety firms, and 3) with the coordination of a developer.

A commercial market with only specialized stores

Assume commercial goods and services are provided by specialized stores. These stores are symmetric and each provide one specific variety. We can think of these firms as small businesses like hair salons, candle stores, dry cleaners, bakeries etc.

Proposition 6. *If* $\Pi(n^*; w, r, m) \geqslant 0$*,* $n = 0$ *is a Nash equilibrium if each variety is provided by specialized stores.*

Proof. The decision of a specialized store is to enter a community SC or not. A store will choose to enter if it makes a positive profit. If $n < n^0$, a store will choose not to enter a SC because $\Pi(n; w, r, m) < 0$. Therefore, $n = 0$ is a Nash equilibrium. □

Proposition 6 shows that if firms are symmetric and each carries one variety, then we cannot rule out the inefficient equilibrium outcome. Without coordination, the symmetric specialized stores may fail to achieve the agglomeration and generate enough revenue to cover the fixed cost. In fact, it almost never happens in real life that small commercial business owners coordinate themselves to operate in a specific location.

A commercial market with multi-variety stores

We do observe that after a big store enters a community, small stores cluster around the big store. If there is a store that offers more varieties than the agglomeration threshold n^0, then this store can make positive profit. In certain communities, the inefficient outcome of no CSC will be overcame by big stores.

Assume there are finite number of multi-variety stores and infinite number of potential entrepreneurs who have the skill to run a specialized business. The number of varieties a firm can offer is exogenously determined by the firm's management and logistical sophistication. For example, Wal-Mart has a sophisticated logistics management, so it offers a large variety of goods. A hair salon provides a specific service because the cost of providing another type of good or service is so high that the owner's optimal strategy is to specialize. In a shopping center that offers n varieties, the profit of a firm that provides k varieties is $k\Pi(n)$.

Proposition 7. *Assume $m \geqslant m_1$. Let $k_{\max}$ be the number of varieties the biggest multi-variety store offers.*

1) $n = 0$ is a Nash equilibrium if $k_{\max} < n^0$.

2) $n = 0$ is a not Nash equilibrium if $k_{\max} \geqslant n^0$.

Proof. 1. The decision of the stores is to enter a community or not. A store will choose to enter if it makes a positive profit. If $k_{\max} < n^0$, the biggest multi-variety store will choose not to enter a community given other stores do not enter the community and locate in the same place because $\Pi(k_{\max}) < 0$. Other stores with $k < k_{\max}$ have the same strategy. Therefore, $n = 0$ is a Nash equilibrium.

2. If $k_{\max} \geqslant n^0$, then entering this community is the dominant strategy for at least the biggest store because $\Pi(k_{\max}) \geqslant 0$. Therefore, $n = 0$ can not be a Nash equilibrium.

□

Proposition 7 indicates that, without a coordinator, whether the inefficient outcome will be eliminated depends on whether the agglomeration threshold n^0 is bigger than the number of varieties carried by the biggest multi-variety firm.

If Wal-Mart is the biggest multi-variety firm, then $k_{\max}$ will be the number of varieties Wal-Mart offers, which is exogenously determined by Wal-Mart's technology. The agglomeration threshold n^0 is endogenously determined by the local wage rate w, land rent r, and consumer income m as summarized in Proposition 8.

Proposition 8. *The agglomeration threshold n^0 decreases with m, increases with wage w and land rent r.*

The proof is in the appendix. Holding the production costs constant, communities with higher consumer income may see a multi-variety store enter and other specialized stores agglomerate around it. This may not happen in low-income communities that have an agglomeration threshold higher than the maximum number of varieties a firm can carry with current technology.

A commercial market with developers, anchor stores, and specialized stores

The possible commercial flourish with the entering of a multi-variety firm in high income communities does not undermine the importance of developers. If there is an emerging high income community, most possibly a developer will identify the opportunity first and build a shopping center. Moreover, a developer may be able to build a SC in communities that do not have enough income to induce the entering of a big store. Compared to big stores, developers have a higher ability to internalize the demand externality. Big stores cannot share the profits of specialized stores and will not take into account the positive demand externality in their decision making. Developers share the profits of specialized stores through leasing contracts.

To investigate the potential market failure in providing commercial services in low-income neighborhoods, I construct a commercial development game in which a developer serves as a central planner of the project. There are three types of agents in this game: the developer, the anchor tenants, and the specialized stores. Even though a commercial development project involves infinite time periods, the game focuses on the period when the parties interact with each other and decide how the payoffs are shared.

In period 0, the commercial development game is played in three stages. Stage 1, the developer incurs a cost to do market analysis and to search for potential anchor tenants. Stage 2, the developer meets with the anchor tenants, negotiate the share of payoffs, and obtains commitments from them. Stage 3, the developer purchases the land, constructs the shopping center, and leases the rest of the spaces to specialized stores. From period 1 on, the shopping center operates and the parties execute the contracts they signed in period 0.

I will solve the period 0 commercial development game using backward induction. The third stage game is played among the developer and the specialized stores. Assume there are a large number of entrepreneurs who can manage a specialized store in a CSC. These potential small business owners compete for the limited spaces available in the shopping center. The competition allows the developer to offer leasing contracts that extract all the profits from specialized stores[6].

Imagine at the third stage, the developer let entrepreneurs bid for slots in the CSC that are not occupied by the anchor tenants. Let r_s be the rent that a specialized store pays for each period. Since no specialized store makes any profit, i.e., $\Pi(n) + r - r_s = 0$, $r_s = \Pi(n) + r$. If the number of varieties committed to the shopping center is so small that no store makes positive "before-rent profit", $\Pi(n) + r < 0$, then no entrepreneur will be interested in bidding for one slot, assuming that there is no negative rent bid, i.e., $r_s > 0$. To start the bidding, a developer has to commit at least $n^{'}$ varieties at the second stage such that $\Pi(n^{'}) + r = 0$. For all $n \in (n^{'}, n^{*}]$, we know $\Pi(n) + r > 0$.

In the second stage, the developer and the anchor tenants negotiate over the total profits of the varieties provided in the CSC. For a CSC with n variety, the total profit each period equals $n\Pi(n)$. Let $i > 0$ be the interest rate. The discounted present value of total profits V over the life of the SC equals $\frac{1+i}{i} n\Pi(n)$. Assume the division of V is determined by the Nash bargaining solution. Let $\theta \in (0, 1)$ be the share that the anchor tenant claims. An increase in θ means an increase in the bargaining power of the the anchor tenant. The payoff to the developer is $(1 - \theta)V$.

In the first stage, the developer incurs a cost c in order to search for an anchor store to fill the $n^{'}$ slots that is required for the success of the third stage game, and chooses n to maximize his or her profit. Since the cost c is sunk when the developer negotiate with the anchor store in the second stage, the developer would not be able to convince the anchor tenant to share the cost. The profit of the developer is $V_d = (1 - \theta)V - c$.[7] The developer will build a SC in a community

[6]According to the RDH, "for a retail center with major tenants, smaller tenants represent the largest income potential for the project. Although major tenants may be the primary generator of customer traffic and the financial foundation for attracting initial capital commitments, in-line shops pay higher rents and generate the greatest profits for the developer."

[7]Bargaining over rents anchor tenants pay or over the total payoff are not different as long as anchor tenants end up paying non-negative rents. There are cases that anchor tenants do not pay rents and also pay less opration costs. These cases are more likely to happen for anchor

only when $V_d \geqslant 0$.

The first-order condition of the developer's profit-maximization

$$\frac{\partial V_d}{\partial n} = (1-\theta)\frac{\partial V}{\partial n} = 0$$

gives the profit-maximizing number of varieties

$$n^{**} = [\frac{2(m-t_o)^2}{t\sigma(\sigma-1)(\alpha w + r)}]^{\frac{\sigma-1}{1+\sigma}}$$

The profit of a developer when the number of varieties is optimally chosen is

$$\begin{aligned} V_d(n^{**}; w, r, m) &= (1-\theta)V(n^{**}; w, r, m) - c \\ &= (1-\theta)\frac{1+i}{i}[\frac{m^2 - n^{**\frac{2}{1-\sigma}}(m-t_o)^2}{t\sigma} - n^{**}(\alpha w + r)] - c \\ &= \frac{(1-\theta)}{t\sigma}\frac{1+i}{i} \\ &\{m^2 - (1+\sigma)(\sigma-1)^{\frac{1-\sigma}{1+\sigma}}[\frac{t\sigma(\alpha w + r)}{2}]^{\frac{2}{1+\sigma}}(m-t_o)^{\frac{2(\sigma-1)}{1+\sigma}}\} - c \end{aligned}$$

If $V_d(n^{**}; w, r, m) \geqslant 0$, the developer will purchase the land with $\frac{1+i}{i} r n^{**}$ and incur the cost c to initiate the project.

Proposition 9. *For* $m \geqslant m_1$, $\frac{\partial V(n^{**}; w, r, m)}{\partial m} \geqslant 0$

The proof is in the appendix. Proposition 9 shows that the total profits of all the stores in a CSC increases with the income level of the community.

Proposition 10. *Assume* $m \geqslant m_1$*, there exists* $m_1 \leq m_2 < m_3$ *such that* $V(n^{**}; w, r, m_2) - c = 0$ *and* $V_d(n^{**}; w, r, m_3) = 0$.
For $m \in [m_2, m_3)$, $V(n^{**}; w, r, m) - c \geqslant 0$ *and* $V_d(n^{**}; w, r, m) < 0$.

Proof. If $V_d(n^{**}; w, r, m_3) = 0$, then $V(n^{**}; w, r, m_3) - c = \frac{\theta c}{1-\theta} > 0$. For $m < m_3$, $V_d(n^{**}; w, r, m) < 0$.

If $V(n^{**}; w, r, m_2) - c = 0$, then for $m > m_2$, $V(n^{**}; w, r, m) - c \geqslant 0$.

$V(n^{**}; w, r, m_3) - c > 0$ implies that $m_3 > m_2$.

Therefore, for $m \in [m_2, m_3)$, $V_d(n^{**}; w, r, m) < 0$ and $V(n^{**}; w, r, m) - c \geqslant 0$. □

tenants in interregional malls and are rarely happen in community shopping centers.

According to Proposition 10, communities with $m \geqslant m_3$ will have their CSCs because the developer's profit $V_d(n^{**}; w, r, m)$ is positive. Communities with $m < m_3$ will have no CSC because $V_d(n^{**}; w, r, m) < 0$. We say communities with income $m \in [m_2, m_3)$ are under-served with commercial goods and services: for these communities, a SC is not only sustainable ($m \geqslant m_1$) but also profitable as a whole ($V(n^{**}; w, r, m) - c \geqslant 0$), and yet no SC gets built.

2.4 Policy intervention and the local economic development programs

The market failure described in the previous section calls for government intervention in under-served communities ($m \in [m_2, m_3)$) to induce private investments in commercial activities. We know from Proposition 8 that the key is to make the developer at least break even, so incentives provided directly to developer surely will work. A lump-sum grant g to the developer that makes $V_d(n^{**}; w, r, m) + g \geqslant 0$ will induce a developer to invest in the project. Other incentives, e.g., low-interest loans and accelerated deductions, to the developer with a value equal to g can achieve the same result as a block grant. Proposition 11 summarizes the changes induced by this policy.

Proposition 11. *For a community with $m \in [m_2, m_3)$, a block grant $g \geqslant -V_d[n^{**}; w, r, m)$ to a developer will induce the developer to build a SC in this community and generate*

- *a private investment from the developer $\frac{1+i}{i} r n^{**} + c$;*
- *permanent jobs $\beta n^{**} Q(n^{**}; w, r, m) + \alpha n^{**}$;*
- *sales revenue $\frac{1+i}{i} \frac{\sigma}{\sigma - 1} n^{**} Q(n^{**}; w, r, m) \beta w$;*
- *total profit $V(n^{**}; w, r, m) + g - c > g$;*
- *a consumer surplus every period $2 \int_0^{z^*(n^{**})} [U(n^{**}, z) - U_o] dz > 0$.*

Proof. If $m \in [m_2, m_3)$, with a subsidy $g \geqslant -V_d(n^{**}; w, r, m)$, the developer's profit will be $V_d(n^{**}; w, r, m) + g \geqslant 0$. Therefore, the developer will purchase the land with a value of $\frac{1+i}{i} r n^{**}$ and incur the cost c to build a SC that provide n^{**} variety of goods and services. Every period, each variety employs $\beta Q(n^{**}; w, r, m) + \alpha$ workers and generate revenue $Q(n^{**}; w, r, m)p = \frac{\sigma}{\sigma-1} Q(n^{**}; w, r, m)\beta w$. Since specialized stores do not make profit, we get the total profit by adding up the profit of the developer and the anchor tenants, which equals $V_d(n^{**}; w, r, m) + g + \theta V(n^{**}; w, r, m) = V(n^{**}; w, r, m) + g - c > g$. Consumers $z \in [0, z^*(n^{**}]$ get a utility gain from patronizing the CSC, $U(n^{**}, z) - U_o > 0$. Every period, the aggregate consumer surplus due to the CSC is $2 \int_0^{z^*(n^{**})} [U(n^{**}, z) - U_o] dz > 0$. □

Proposition 11 shows that providing incentives to developers who invest in under-served communities is welfare enhancing. The block grant g to a developer leads to an economic profit bigger than g. In addition, consumers in these communities benefit from saving a trip to the outside shopping center.

Even though in this model the developer's investment in land purchase and the jobs in the CSC are not gains because it assumes that the land and the workers will be used by other economic activities anyway, in reality they are often important parts of gains for distressed areas. High unemployment rates and deterioration of properties are two of the major problems that poor communities have to face. If the goal is to create jobs and to stimulate sustainable economic activities in distressed areas, the government should also provide incentives to developers to invest in communities with $m \in [m_1, m_2)$. A CSC in such a community will be sustainable once it is built and will generate the permanent jobs and consumer surplus just as a CSC in communities with $m \in [m_2, m_3)$. The only difference is that the total profit of the CSC will be lower than the block grant because $V(n^{**}; w, r, m) - c < 0$ for $m < m_2$.[8]

This result is consistent with commercial development successes in some of the federal urban EZs. For example, with the grants from federal EZs program, New York's Harlem has seen the opening of Harlem USA in 2001 and East River

[8] A grant should not exceed $-V_d(n^{**}; w, r, m_1)$ because providing a $g > -V_d(n^{**}; w, r, m_1)$ would make a developer enter a community that can not sustain a CSC.

Plaza in 2009, and several ongoing commercial development projects, either in the form of public and private joint venture or injection of either public funding or low-interest loans to a developer.

Can we attribute the success of commercial revitalization to the block grants? Would commercial revitalization be successful with just employment tax abatements? These questions are important to answer because the federal EZ program also offer substantial employment tax credits to businesses that operate and hire workers live in the zone areas.

Assume the employment tax abatements are tax rebates, i.e., they can effectively lower labor costs regardless of the profitability of a firm.[9] Let s be the effective wage subsidy that is equivalent to the employment tax rebates. With the employment tax rebates, the effective labor costs of the stores are $w(1-s)$. The developer will choose an

$$n^s = [\frac{2(m-t_o)^2}{t\sigma(\sigma-1)[\alpha w(1-s)+r]}]^{\frac{\sigma-1}{1+\sigma}} > n^{**} = [\frac{2(m-t_o)^2}{t\sigma(\sigma-1)(\alpha w+r)}]^{\frac{\sigma-1}{1+\sigma}},$$

and will enter this community if $V_d(n^s; w, r, m) \geqslant 0$.

Clearly if s is not big enough, it will not be able to make $V_d(n^s; w, r, m) \geqslant 0$ and will not induce developers to invest in these under-served communities. If in some communities, most likely communities that have an income level very close to m_3, they do work, the worth of the minimum loss of tax revenue will be much bigger than the worth of minimum block grants to the developer because of oversupply of shopping spaces by the developer and the revenue loss to the anchor tenants.

It is not surprising that employment tax abatements alone are much less effective in solving the under-presence of CSCs in low-income areas. As a place-based people strategy for promoting economic development in distressed areas, employment tax abatements give advantages to residents of poor neighborhoods

[9]Employment tax credits can only be claimed against taxable profits of a firm that employs workers. In this model, special stores do not make any profit and the developer does not employ any workers. None of them would be able to use the employment credit under the current market structure.

and lower labor costs for firms that operate in targeted zone areas and hire workers who live in these areas. This policy is not designed to deal with inefficiency associated with lack of economic agglomeration.

While the policy discussion is based on commercial development, it provokes thinking about geographically targeted economic development strategies. In a review of "Enterprise Zones", Hirasuna and Michael (2005) states that "a consensus appears to be forming that tax incentives have negligible to small positive effects upon the state economy" (p14), and that "tax incentives may be most effective in already economically viable areas" (p15).[10] In an evaluation of round I federal urban EZs, Busso and Kline (2007) also point out that tax credits are unlikely to be the only source of the observed employment gain. Consistent with the evidence, if the problem with these distressed areas is lack of economic agglomeration, tax abatements alone can hardly help them to achieve sustainable economic development. Under the current federal and state budgetary situation, it is important to realize that the question we should ask is not whether local development programs work but what kind of strategies work.

2.5 Conclusion

This paper presents a model of commercial development in which under-provision occurs when the market cannot achieve the necessary economic agglomeration. It shows that big stores and/or commercial developers can solve the coordination problem to some extent. However, big stores have technical limitation in providing more varieties and they cannot internalize the demand externalities to small stores; Developers, through leasing contracts with all stores in a CSC, can internalize the demand externalities, but they have to incur costs before they find the anchor tenant, who will claim a share of payoffs of the CSC. With this market structure, low-income communities may be under-served with commercial goods

[10] The authors summarize the findings in the previous studies that regions with already low unemployment rates and with historically high levels of investment in manufacturing facilities and equipment are more likely to grow in response to tax incentives than others, and these regions are usually suburban areas in stead of central cities. (page 15)

and services. Providing block grants directly to developers can solve the market failure and will generate an economic profit bigger than the block grant. Employment tax abatements alone are much less effective, if not entirely ineffective, in commercial revitalization.

The literature on urban stress used to emphasize problems caused by the "spacial mismatch" between jobs and residential locations. As a consequence, geographically targeted economic development policies, e.g. employment tax abatements, usually are designed to encourage firms to operate in distressed areas. This paper identifies a problem that are different from what have been identified in the "spacial mismatch" literature: residents of distressed areas have to shop outside of their community. It is important to devote more research to understanding the impact on residents of the most distressed areas.

Finally, if the lack of economic agglomeration is what deters firms to enter low-income areas, tax abatements alone will not be effective in general. Policymakers should not dismiss or endoss local economic development programs based on the overall economic performance of zone areas. In stead, they should pay more attention to the effects of different policy components.

2.6 Appendix

2.6.1 Proof of Proposition 3

Proof. If $n < \left(\frac{m}{m-t_o}\right)^{1-\sigma}$, $\frac{\partial\Pi}{\partial n} = 0$.

If $n \in [\left(\frac{m}{m-t_o}\right)^{1-\sigma}, 1]$, the first derivative of Π with respect to n is

$$\frac{\partial\Pi}{\partial n} = \frac{\frac{1+\sigma}{\sigma-1} n^{\frac{2}{1-\sigma}} (m-t_o)^2 - m^2}{t\sigma n^2}$$

The second derivative of Π with respect to n is

$$\frac{\partial^2\Pi}{\partial n^2} = 2\frac{m^2 - \frac{(1+\sigma)\sigma}{(\sigma-1)^2} n^{\frac{2}{1-\sigma}} (m-t_o)^2}{t\sigma n^3}$$

$\frac{\partial^2\Pi}{\partial n^2} \le 0$ when $n \le \left(\frac{m}{m-t_o}\right)^{1-\sigma} \left(\frac{(\sigma-1)^2}{(1+\sigma)\sigma}\right)^{\frac{1-\sigma}{2}}$. $\frac{\partial\Pi}{\partial n} = 0$ when

$$n^* = \left(\frac{m}{m-t_o}\right)^{1-\sigma} \left(\frac{\sigma-1}{1+\sigma}\right)^{\frac{1-\sigma}{2}}.$$

We can see $n^* < \left(\frac{m}{m-t_o}\right)^{1-\sigma} \left(\frac{(\sigma-1)^2}{(1+\sigma)\sigma}\right)^{\frac{1-\sigma}{2}}$. If $m \le \frac{t_o}{1-\left(\frac{\sigma-1}{1+\sigma}\right)^{\frac{1}{2}}}$, i.e., $n^* < 1$ maximizes Π on the interval $[\left(\frac{m}{m-t_o}\right)^{1-\sigma}, 1]$. If $n^* > 1$, then $\frac{\partial\Pi}{\partial n} \mid n = 1 > 0$, then $n = 1$ maximizes Π on the interval $[\left(\frac{m}{m-t_o}\right)^{1-\sigma}, 1]$. □

2.6.2 Proof of Proposition 4

Proof. If $m \le \frac{t_o}{1-\left(\frac{\sigma-1}{1+\sigma}\right)^{\frac{1}{2}}}$, $n^* = \left(\frac{m}{m-t_o}\right)^{1-\sigma} \left(\frac{\sigma-1}{1+\sigma}\right)^{\frac{1-\sigma}{2}}$, then

$$\Pi(n^*; w, r, m) = \frac{2m^{\sigma+1}(m-t_o)^{1-\sigma}}{t\sigma(\sigma-1)^{\frac{1-\sigma}{2}}(1+\sigma)^{\frac{1+\sigma}{2}}} - \alpha w - r$$

Differentiate $\Pi(n^*; w, r, m)$ with respect to m, we get

$$\frac{\partial\Pi(n^*; w, r, m)}{\partial m} = \frac{2m^{\sigma}(m-t_o)^{-\sigma}[2m - (1+\sigma)t_o)]}{t\sigma(\sigma-1)^{\frac{1-\sigma}{2}}(1+\sigma)^{\frac{1+\sigma}{2}}}$$

$\frac{\partial\Pi(n^*;w,r,m)}{\partial m} \geqslant 0$ if $\frac{(1+\sigma)t_o}{2} \le m \le \frac{t_o}{1-\left(\frac{\sigma-1}{1+\sigma}\right)^{\frac{1}{2}}}$.

If $m > \frac{t_o}{1-\left(\frac{\sigma-1}{1+\sigma}\right)^{\frac{1}{2}}}$, $n^* = 1$, then

$$\Pi(n^*; w, r, m) = \frac{t_o(2m - t_o)}{t\sigma} - \alpha w - r$$

Differentiate $\Pi(n^*; w, r, m)$ with respect to m, we get

$$\frac{\partial \Pi(n^*; w, r, m)}{\partial m} = \frac{2t_o}{t\sigma} > 0$$

□

2.6.3 Proof of Proposition 8

Proof. Differentiate Π with respect to w, r, and m, we get

$$\partial \Pi / \partial w = -\alpha \partial \Pi / \partial r = -1$$

and

$$\frac{\partial \Pi}{\partial m} = \frac{2m - 2n^{\frac{2}{1-\sigma}}(m - t_o)}{t\sigma n}.$$

Assume $n^0 > \left(\frac{m-t_o}{m}\right)^{\frac{\sigma-1}{2}}$, then $\frac{\partial \Pi}{\partial m} \mid (n = n^0) > 0$. From Corollary 1 and Corollary 2, we know $\frac{\partial \Pi}{\partial n} \mid (n = n^0) > 0$.

Use the implicit function theorem, we can show that

$$\frac{\partial n^0}{\partial m} = -\frac{\partial \Pi / \partial m}{\partial \Pi / \partial n} < 0$$
$$\frac{\partial n^0}{\partial w} = -\frac{\partial \Pi / \partial w}{\partial \Pi / \partial n} > 0$$
$$\frac{\partial n^0}{\partial r} = -\frac{\partial \Pi / \partial m}{\partial \Pi / \partial r} > 0.$$

□

2.6.4 Proof of Propostion 9

Proof. For $m > m_1$, $V\,(n^{**}) > n^*\Pi(n^*; w, r, m) \geqslant 0$, which means that

$$m^2 - (1+\sigma)(\sigma-1)^{\frac{1-\sigma}{1+\sigma}}[\frac{t\sigma(\alpha w + r)}{2}]^{\frac{2}{1+\sigma}}(m-t_o)^{\frac{2(\sigma-1)}{1+\sigma}} \geqslant 0$$

$$\frac{m}{(m-t_o)^{\frac{(\sigma-1)}{1+\sigma}}} \geqslant (1+\sigma)(\sigma-1)^{\frac{1-\sigma}{1+\sigma}}[\frac{t\sigma(\alpha w + r)}{2}]^{\frac{1}{1+\sigma}}$$

If $(\frac{1+\sigma}{1-\sigma})^{\frac{1}{2}} > [\frac{t\sigma(\sigma-1)(\alpha w+r)}{2}]^{\frac{1}{1+\sigma}}$, then

$$\begin{aligned}\frac{m}{(m-t_o)^{\frac{\sigma-3}{1+\sigma}}} &> \frac{m}{(m-t_o)^{\frac{\sigma-1}{1+\sigma}}} \\ &> (\frac{1+\sigma}{1-\sigma})^{\frac{1}{2}}[\frac{(\sigma-1)t\sigma(\alpha w + r)}{2}]^{\frac{1}{1+\sigma}} \\ &> [\frac{t\sigma(\sigma-1)(\alpha w + r)}{2}]^{\frac{2}{1+\sigma}}\end{aligned}$$

Differentiate $V(n^{**})$ with respect to m, we get

$$\frac{\partial V(n^{**})}{\partial m} = \frac{2}{t\sigma}\{m - [\frac{t\sigma(\sigma-1)(\alpha w + r)}{2}]^{\frac{2}{1+\sigma}}(m-t_o)^{\frac{\sigma-3}{1+\sigma}}\} > 0$$

□

Chapter 3

Economic analysis of trade in higher education

3.1 Introduction

For a long time, education has been considered to be a non-traded service. People used to think of it as a public good that should be provided by the government, which may still be true at the primary and secondary level in most countries. However, higher education and training is becoming a fast growing global business, and was estimated to be a $2 trillion industry in 1999 (Merrill Lynch). In recognition of that, the GATS (General Agreement on Trade in Services) covered education as one of the traded services during the Uruguay Round. So far, four countries, including the United States (in 2000), Australia (in 2001), New Zealand (in 2001), and Japan (in 2002), have submitted proposals for the WTO members to negotiate. And 44 countries have made commitments to different level of trade in education.

The GATS classifies trade in education by the four modes of services traded, including cross-border supply (mode 1), consumption abroad (mode 2), commercial presence (mode 3), and presence of natural persons (mode 4). The traditional mode of trade in education services has been international student exchange at the tertiary level, which corresponds to mode 2 and is the most liberalized mode.

The GATS negotiation emphasizes the liberalization of the three other modes, especially commercial presence. Developed countries, like the U.S. and Australia, seek to remove obstacles that prohibit universities or institutions to open joint programs, affiliates, and campuses in other countries. According to Hira (2003), U.S. universities, for example, University of Maryland, Johns Hopkins, Temple Universities, etc, have identifiable affiliates in at least 40 countries. Meek (2006) reports that offshore programs of Australian universities increase from 895 in 2000 to 1569 in 2003, and the number of Australian offshore students increased from 28,266 in 2001 to 58,513 in 2003, which is more than doubled.

The literature studying trade in higher education is mostly done by educators. The United Nations Educational, Scientific and Cultural Organization (UNESCO) sponsored a series of conferences and meetings on trade in educational services. The most influential ones are the World Conference on Higher Education (WCHE) (Paris, 1998), the Meeting of Higher Education Partners (MHEP) (Paris, 2003), and the Regional Seminar on the Implications of WTO/GATS on Higher Education in Asia and the Pacific (Seoul, 2005). The proceedings of these conferences offer a rich description of the current situation, the rationales, and the trend of trade in higher education. According to this literature, the major exporters of higher education are the U.S., the U.K., Australia, and Canada,[1] among which Australia has the biggest growth during the period 1970 to 1999 and is the most competitive exporter in the 1990s (Larsen, Martin, and Morris, 2002). The rationales of the exporting countries are mostly economic, even though this profit driven exporting may have different country backgrounds.[2] The major importers are from South-east Asia, including China, Hong Kong, Malaysia, Singapore, and India, etc. The rationales of the importing countries are also mostly economic with slightly different emphasis. China and Malaysia claim that the most important rationale to liberalize trade in higher education is to improve the quality of its human resources in order to become an industrialized nation. (Zhang 2003, and

[1]The exporters are ranked by “export value” of mode 2 trade.

[2]For example, in the U.S., the private education and training providers try to expand their business to the world market to increase the profit margin. In Australia, universities suffer from public funding reduction and seek to survive through success in international market (Meek 2005).

Gill 2005).

Even though trade in higher education has clear economic rationales for both exporters and importers, and ranked as the U.S. sixth largest service exporting sector (US BEA, 2000) and Australian fourth largest export industry in 2003, economic theories devoted to trade in education are very scarce. To my knowledge, the exporting of higher education from developed countries to less developed countries through commercial presence has not been investigated theoretically. A remotely relevant paper is by Kim (1998, JDE). In this paper, he designs a model to study an individual's decision to study abroad and its impact on the growth rate of the knowledge importing country. His model has a couple of limitations. First, in this decentralized economy there is no formal higher education system. Second, in the production skilled and unskilled workers are perfect substitutes in terms of efficient units, so it is impossible to analyze the impact of technological change on demand for higher education. Third, the knowledge exporting country is assumed to be large, so there is no general equilibrium effect on the exporters. This paper tries to analyze the impact of trade in higher education on both the exporting and importing countries in a general equilibrium model with two large open economies.

In this model, the higher education system consists of a public-financed research institution and a private teaching sector with competitive teaching institutions. I adopted this set up because, first of all, it is consistent with the current structure of higher education system for most countries (Romero and Rey, 2004), and second of all, the GATS negotiation respects members rights to subsidize its public research institutions and only seeks fair competition in the private education sector. Knowledge is created in the research institution and distributes to the young generation through old researchers and teachers. The consumption good production sector uses three types of workers research workers, skilled workers, and unskilled workers. This set up allows us to investigate the impact of technology change on the teaching sector. Adding international mobility of research students, this model also offers an explanation of the return behavior of foreign trained research students. It is important to note that this is not a paper about optimal policy, but a positive look at the economic impacts of liberalizing trade in higher education on exporting and importing countries.

The rest of the paper proceeds as follows. Section II sets up of the model, solves for the equilibrium in a closed economy, and does some comparative static analysis. Section III analyzes the trade pattern and the impacts of trade in educational services on both the advanced and less advanced country. Section IV extends the model to accommodate international mobility of research students and identifies the mode and the sufficient condition for endogenous return to occur. Section V concludes.

3.2 A closed economy with overlapping generations

I consider an economy that is composed of a government, a public-financed research institution, a teaching sector, a consumption good production sector, and two-period lived overlapping generations. Each generation has the same population size N. Individuals differ in their learning ability, $a \in [0, 1]$, which affects their contribution to the aggregate human capital creation and distribution process and is public information.[3] Each individual is endowed with one unit of time in each period. Without appreciation of leisure in the utility function, an individual devotes all his or her time to maximize income.

3.2.1 Individuals

In the first period of their lives, individuals who do not receive an admission from the research institution choose either to go to a teaching institution and be a skilled worker in the second period or to work as an unskilled worker in both periods. Those who receive admissions from the research institution have one more option besides the above two. If an individual chooses to accept the admission and go to the research institution, in the second period he or she should decide whether

[3] Alternatively, we can think of a costless exam that reveals individual's ability to the society.

to work for the research institution as a researcher, or to work in the teaching sector as a teacher, or to be a research worker in the production sector.

For individuals born in period $t-1$, those who attended the research institution in $t-1$ become researchers, teachers, and research workers in period t. Since they have the same human capital level and are perfectly mobile across the research, teaching, and production sectors, there should be no arbitrage between the three occupations, i.e., the wage of researcher W_t^R, the wage of teachers W_t^T, and the wage of the research workers $W_{R,t}$ should be the same:

$$W_t^R = W_t^T = W_{R,t}$$

For individuals born in period t, those who attend the research institution at t pay no tuition and graduate with a human capital level $h_(R, t+1)$, so their lifetime income equals

$$I_R^t = W_{R,t+1} = W_{R,t+1} = W_{t+1}^R = W_{t+1}^T \tag{3.1}$$

Those who attend a teaching institution in t and become skilled worker in period $t+1$ need to pay tuition p_t in t and get paid $W_{S,t+1}$ at $t+1$, so their lifetime income equals

$$I_S^t = W_{S,t+1} - (1+r_t)p_t$$

Those who work as unskilled workers in period t and $t+1$ get paid by the unskilled wage in both period, so their lifetime income equals

$$I_U^t = W_{U,t+1} + (1+r_t)W_{U,t}$$

Along a balanced growth path (BGP), wage rates grow at $(1+g)^{\alpha_1+\alpha_2}$ because the growth of knowledge affects the production growth through efficient units of research workers and skilled workers. Assume individuals have perfect foresight when they make their decisions at period t, the anticipated wages in period $t+1$ will be

$$W_{j,t+1} = (1+g)^{\alpha_1+\alpha_2} W_{j,t}, j = R, S, U.$$

An individual's ability matters in the human capital creation and distribution process. The research institution values students' ability and attracts students who meet its admission cutoff by tuition waiver that makes these selected students have a higher lifetime income than the rest of the population.

$$I_R^t > I_S^t I_R^t > I_U^t$$

However, the private teaching institutions in a perfectly competitive market do not offer different tuition for different ability, so individuals that are not selected by the research institution should have equal lifetime income because they are viewed the same in the teaching and the production sector. The non-arbitrage condition between skilled workers and unskilled workers is

$$I_S^t = I_U^t$$

3.2.2 The production sector

The production of the consumption good uses three types of workers – research workers $L_{R,t}$, skilled workers $L_{S,t}$, and unskilled workers $L_{U,t}$. The technology is assumed to have constant returns to scale in terms of efficient units of the three factors. I consider a three-factor Cobb-Douglas production function

$$Y_t = G(l_{R,t}, l_{S,t}, l_{U,t}) = l_{R,t}^{\alpha_1} l_{S,t}^{\alpha_2} l_{U,t}^{1-\alpha_1-\alpha_2}, \alpha_1, \alpha \in (0,1)$$

where $l_{R,t} = L_{R,t}h_{R,t}, l_{S,t} = L_{S,t}h_{S,t}, l_{U,t} = L_{U,t} = L_U^t + L_U^{t-1}$ are efficient units of three factors, L_U^t and L_U^{t-1} are unskilled workers born in period t and period $t-1$ respectively, and $h_{R,t}$ and $h_{S,t}$ are the human capital level of the research workers and the skilled workers respectively.

The government imposes a tax τ_t on the production of the consumption good. In a perfectly competitive sector, the efficient unit of each factor is paid by its after tax marginal value $(1-\tau_t)\omega_{R,t}$, $(1-\tau_t)\omega_{S,t}$, and $(1-\tau_t)\omega_{U,t}$. The wage rates of the three types of workers are

$$W_{R,t} = (1-\tau_t)\omega_{R,t}h_{R,t} \tag{3.2}$$

$$W_{S,t} = (1-\tau_t)\omega_{S,t}h_{S,t} \tag{3.3}$$

$$W_{U,t} = (1-\tau_t)\omega_{U,t} \tag{3.4}$$

3.2.3 The research institution

Two activities occur in the research institution: the creation of knowledge and the distribution of human capital.[4] In the advanced country, the country on the knowledge frontier, the creation process involves researchers, R_t, the average talent of the students, $\overline{a_{R,t}}$, and the current stock of knowledge, A_t. The technology is summed by a production function

$$A_{t+1} = F(R_t, \overline{a_{R,t}}, A_t) = (R_t)^{\varepsilon}(\overline{a_{R,t}})^{\gamma}A_t,$$

where $0 < \gamma, \varepsilon < 1$.

In the less advanced country, knowledge creation depends not only on its own stock of knowledge A_t^* but also the knowledge level at the frontier A_t. The technology is given by

$$A_{t+1}^* = (R_t^*)^{\varepsilon}(\overline{a_{R,t}^*})^{\gamma}(\theta A_t^* + \lambda A_t),$$

where $0 < \theta, \lambda < 1$.[5]

The human capital distribution process happens the same time the knowledge is created. Each researcher is obligated to teach k students (the same students who contribute their talents to create new knowledge) in order to get paid by the government at W_t^R.[6] In period t, the number of students enrolled in the research institution is given by

$$S_{R,t} = kR_t$$

These students will graduate at the beginning of period $t+1$ with a human capital level $h_{R,t+1} = A_{t+1}$.

[4] "Knowledge" and "human capital" are interchangable in this paper.

[5] This modeling choice follows Benhabib and Spiegel (1994). I assume the difference between "the endogenous growth rate" and "the catch up rate" is determined by θ and λ.

[6] This obligation can be thought of as the minimum teaching load for a researcher. In reality, most if not all researchers have to fulfill this obligation.

Assume there is no government spending other than the wage expenditure of the research institution and the government adjusts the tax rate τ_t to maintain a balanced budget:

$$W_t^R R_t = \tau_t Y_t \tag{3.5}$$

The research institution accepts the financial support and the associated enrollment requirement from the government, and then chooses R_t to maximize the human capital quality of its graduates.[7]

Individuals selected by the research institution have a higher lifetime income than the rest of the population. The research institution can always choose its students, so it sets an admission cutoff $a_{R,t}$ and selects individuals with ability $a \geqslant a_{R,t}$. Assume ability is uniformly distributed in [0,1] for simplicity, the mean ability of students in the research institution is

$$\overline{a_{R,t}} = \frac{1 + a_{R,t}}{2} = 1 - \frac{kR_t}{2N}$$

In the advanced country, the research institution chooses R_t to maximize

$$h_{R,t+1} = A_{t+1} = (R_t)^{\varepsilon}(\overline{a_{R,t}})^{\gamma} A_t = (R_t)^{\varepsilon}(1 - \frac{kR_t}{2N})^{\gamma} A_t$$

and the first-order condition is

$$\varepsilon(R_t)^{\varepsilon-1}(1 - \frac{kR_t}{2N})^{\gamma} + \gamma(R_t)^{\varepsilon}(1 - \frac{kR_t}{2N})^{\gamma-1}(-\frac{k}{2N}) = 0$$

In the less advanced country, the research institution chooses R_t^* to maximize

$$h^*_{R,t+1} = A^*_{t+1} = (R_t^*)^{\varepsilon}(\overline{a^*_{R,t}})^{\gamma}(\theta A_t^* + \lambda A_t)$$

where $\overline{a^*_{R,t}} = 1 - \frac{kR_t^*}{2N}$ and the first-order condition is

$$\varepsilon(R_t^*)^{\varepsilon-1}(1 - \frac{kR_t^*}{2N})^{\gamma} + \gamma(R_t^*)^{\varepsilon}(1 - \frac{kR_t^*}{2N})^{\gamma-1}(-\frac{k}{2N}) = 0$$

[7]Winston (1999) point out that the objective of a non-profit institution is often "fuzzy" because the administrator is motivated by a complex incentive structure. In higher education, the goal appears to be "maintaining or improving the quality of the educational services they supply and the equity with which they are provided" (Bowen and Breneman, 1993). In this paper, I assume the research institution has a single objective, which is to maximize the quality of their students' human capital.

The number of researchers, hence the admission cutoff, the number of research students, and the knowlege growth rate are solved from the research institution's maximization problem independent of other equilibrium conditions:

$$R = R^* = \frac{\varepsilon}{\varepsilon+\gamma}\frac{2N}{k} \tag{3.6}$$

$$a_{R,t} = a^*_{R,t} = \frac{\gamma-\varepsilon}{\gamma+\varepsilon} \tag{3.7}$$

$$S_R = S^*_R = \frac{2N\varepsilon}{\gamma+\varepsilon} \tag{3.8}$$

The advanced country and the less advanced country have the same number of researchers and students in their research institutions and the same admission cutoff. The ratio of researchers to the population $\frac{R}{N} = \frac{R^*}{N^*} = \frac{\varepsilon}{\varepsilon+\gamma}\frac{2}{k}$ increases if ε the contribution of researchers in the knowledge creation increases, or if γ the contribution of average ability of students decreases, or if k the number of students a researcher obligated to teach decreases.

In the advanced country, knowledge grows at a constant rate g with

$$1+g = \frac{A_{t+1}}{A_t} = (\frac{\varepsilon}{\varepsilon+\gamma}\frac{2N}{k})^{\varepsilon}(\frac{\gamma}{\gamma+\varepsilon})^{\gamma}.$$

[8]

In the less advanced country, the knowledge growth rate equals

$$1+g^*_t = \frac{A^*_{t+1}}{A^*_t} = (1+g)(\theta+\lambda\frac{A_t}{A^*_t}) = (1+g)(\theta+\lambda b_t)$$

where b_t is the knowledge gap between the advanced and less advanced country at t. The evolution of the knowledge gap is given by the difference equation

$$b_{t+1} = \frac{A_{t+1}}{A^*_{t+1}} = \frac{A_{t+1}}{A_t}\frac{A_t}{A^*_t}\frac{A^*_t}{A^*_{t+1}} = \frac{1+g}{1+g^*_t}b_t = \frac{b_t}{\theta+\lambda b_t}. \tag{3.9}$$

The steady state knowledge gap $b = (1-\theta)/\lambda$, which is associated with a constant growth rate $1+g^* = 1+g$. Appendix 3.6.1 proves the existence, uniqueness, and local stability of this steady state.

[8]Knowledge grows faster if the student-to-researcher ratio k is lower. This does not mean a smaller k is always better for the economy because a smaller k is associated with a smaller pool of people who have the highest knowledge level next period.

The steady state knowledge gap will be bigger if international knowledge spillover, measured by λ, is smaller. λ can differ across countries and fields, or change over time. For instance, knowledge spillover may be bigger for less advanced countries that use the same language by the frontier country; a field that has a quicker circulation of publication may have a bigger spillover effect; improvement of internet access may increase knowledge spillover from the frontier over time.

3.2.4 The teaching sector

The teaching sector distributes human capital in a perfectly competitive market . Teaching institutions do not offer different tuition p_t to compete for higher ability students, or behave strategically in any way. Teachers are paid at W_t^T to teach m students. In period t, the number of students enrolled in the teaching sector is given by

$$S_{T,t} = mT_t$$

where T_t is the number of teachers. These students will graduate at the beginning of period $t+1$ and become skilled workers in the production sector. Their human capital level $h_{S,t+1}$ is determined by the knowledge level of the teachers and the mean ability level of the student body

$$h_{S,t+1} = H(\overline{a_{S,t}}, A_t) = \overline{a_{S,t}} A_t.$$

Teaching institutions take tuition p_t and teachers wage W_t^T as given, and maximize profit by setting the marginal revenue from educating a student equals to its marginal cost:

$$p_t = \frac{W_t^T}{m}. \tag{3.10}$$

3.2.5 Equilibrium

Assume there exits an international loan market with perfectly elastic supply at interest rate $r_t = t$. Let L_U^t and L_U^{t-1} be the number of unskilled workers born in t and $t-1$ respectively. Given the interest rate r, a perfect foresight equilibrium for this economy is an allocation of the young generation $\{S_{R,t}, S_{T,t}, L_U^t\}$, an allocation of the old generation $\{R_{t,}T_t, L_{R,t}, L_{S,t}, L_U^{t-1}\}$, a set of consumptions and loans $\{c_t^t, c_{t+1}^t, d^t\}$, a set of wages $\{W_t^R, W_t^T, W_{R,t}, W_{S,t}, W_{U,t}\}$, a tuition for the teaching institutions p_t, and a tax rate τ_t, such that 1) individuals maximize their lifetime income and utility, 2) the research institution maximize its education quality, 3) the government has balanced budget, 4) the teaching institutions and consumption production firms maximize their profits, and 5) the labor markets clear.

The labor market clearing conditions (LMCCs) for research, skilled, and unskilled workers are

$$S_R = R + T_t + L_{R,t} \tag{3.11}$$

$$S_{T,t-1} = L_{S,t} = mT_{t-1} \tag{3.12}$$

$$L_U^t + L_U^{t-1} = L_{U,t} \tag{3.13}$$

The system is pinned down once we know the evolution of the number of teachers in the economy. The non-arbitrage condition between skilled and unskilled worker, equation (3.2.1), the non-arbitrage condition between teachers and research workers, equation (3.1), the labor market clearing conditions, equations (3.11), (3.12), (3.13), the wage equations (3.2), (3.3), (3.4) , and the tuition equation (3.10) together describe the evolution of number of teachers over time:

$$\frac{\alpha_2(1+g)^{\alpha_1+\alpha_2}}{mT_{t-1}} - \frac{(1+r)\alpha_1}{m(kR-R-T_t)} - \frac{[(1+g)^{\alpha_1+\alpha_2}+(1+r)](1-\alpha_1-\alpha_2)}{(N-KR-mT_{t-1})+(N-kR-mT_t)} = 0 \tag{3.14}$$

Appendix B proves the existence and uniqueness of the balanced growth path (BGP) with $T_t = T_{t-1} = T > 0$ and gives the condition for the local stability of the BGP. Define $\Theta \equiv \frac{\alpha_2(1+g)^{\alpha_1+\alpha_2}}{nT} - \frac{(1+r)\alpha_1}{m(kR-R-T)} - \frac{[(1+g)^{\alpha_1+\alpha_2}+(1+r)](1-\alpha_1-\alpha_2)}{2(N-kR-mT)}$.

Proposition 12. *There exists a unique* $T^A \in (0, \min\{(k-1)R, \frac{N-kR}{m}\})$ *such that* $\Theta = 0$.

Proof. Differentiate Θ with respect to T,

$$\frac{\partial \Theta}{\partial T} = -[\frac{\alpha_2(1+g)^{\alpha_1+\alpha_2}}{nT^2} + \frac{(1+r)\alpha_1}{m[(k-1)R-T]^2} + \frac{[(1+g)^{\alpha_1+\alpha_2}+(1+r)](1-\alpha_1-\alpha_2)m}{2(N-kR-mT)^2}] < 0.$$

Since $\Theta \to +\infty$, $T \to 0$, $\Theta \to -\infty$, $T \to \min\{(k-1)R, \frac{N-kR}{m}\}$, and $\frac{\partial \Theta}{\partial T} < 0$, there must be a unique $T^A \in (0, \min\{(k-1)R, \frac{N-kR}{m}\})$ such that $\Theta = 0$. □

Now we are ready for some comparative static analysis. The key parameter is the output share of skilled worker α_2 and the interest rate r. An increase in the interest rate r increases both the direct and opportunity costs of education, therefore, the number of teachers should decrease in the steady state. An increase in α_2 is an increase in the contribution of skilled workers to the production sector. When a country becomes industrialized, the technology upgrade will induce an increase in α_2. As a matter of fact, whenever there is a skill biased technology change, α_2 will increase. In this situation, we expect the demand for skilled workers to increase, which increases the demand for teachers. The experience of China and Malaysia may be good examples for this mechanism. Both countries have significant inflow of FDIs and actively participate in international trade. The underline change of production technology creates a huge demand for skilled workers. Correspondingly, we observe a huge expansion of the higher education system in both countries. In China, the total enrollments in higher education increased from 6.4 million to 15.1 million between 1998 and 2002. During the same period, the number of private colleges and universities in Malaysia has increased from around 100 to 690. The comparative static analysis is summed by Proposition 13.

Proposition 13. *The steady state number of teachers* T^A *decreases with the interest* r *and increases with the output share of skilled workers in the production* α_2.

Proof. Differentiate Θ with respect to $(1+r)$, we get

$$\frac{\partial\Theta}{\partial(1+r)} = -[\frac{\alpha_1}{m(kR-R-T)} + \frac{(1-\alpha_1-\alpha_2)}{2(N-kR-mT)}] < 0.$$

Use implicit function theorem (IFT),

$$\frac{\partial T^A}{\partial(1+r)} = -\frac{\partial\Theta/\partial(1+r)}{\partial\Theta/\partial T} < 0.$$

Differentiate Θ with respect to α_2, we get

$$\frac{\partial\Theta}{\partial\alpha_2} = (1+g)^{\alpha_1+\alpha_2}[\frac{\ln(1+g)\alpha_2+1}{mT} + \frac{1-\ln(1+g)(1-\alpha_1-\alpha_2)}{2(N-kR-mT)}] + \frac{1+r}{2(N-kR-mT)} > 0.$$

Again use IFT,

$$\frac{\partial T^A}{\partial\alpha_2} = -\frac{\partial\Theta/\partial\alpha_2}{\partial\Theta/\partial T} > 0.$$

□

3.3 Trade in educational services

3.3.1 Trade Pattern

I assume there are two economies that are identical in every aspect except the initial stock of knowledge in the research institution and the associated knowledge creation technology. According to the analysis in section II, along their autarky BGP, these two economies have the same allocation of people, tax rate, and growth rate.

Assume 1) the home country is the advanced country at the knowledge frontier and the foreign country is the less-advanced country and $b = \frac{A_0}{A_0^*} = \frac{1-\theta}{\lambda} > 1$; 2) trade in education services is liberalized that there is no barriers or additional cost associated with trade in educational services.

Proposition 14. *Teachers in the advanced country will export their education services to the less advanced country.*

Let $p_{x,t}$ be the tuition teachers from the advanced country charge in the less-advance foreign country. The necessary and sufficient condition for Proposition 14 to hold is $p_{x,t} > p_t$, which means teachers from advanced country will have a higher marginal income teaching in the foreign country. Detailed math proof is in the appendix.

Let $W^{*h}_{S,t+1}$ be the wage rate of skilled workers trained by teachers from the advanced country and $W^*_{U,t}$ be the wage rate of unskilled workers in the less developed country. $W^{*h}_{S,t+1} = (1-\tau)\omega^*_{S,t+1}h^{*h}_{S,t+1}$, where $\omega^*_{S,t+1}$ is the return of efficient unit of skilled workers in the less developed country, and $h^{*h}_{S,t+1}$ is the human capital level of skilled workers trained by teachers from the advanced country. Since the mean ability of students attending teaching institutions are the same in the two economies, $h^{*h}_{S,t+1}$ equals $h_{S,t+1}$ because they are trained by teachers with the same knowledge level A_t. However, $\omega^*_{S,t+1}$ is bigger than $\omega_{S,t+1}$ because efficient units of skilled workers are scarcer in the foreign country. Therefore, the benefit to get the same education is higher for individuals in the less advanced country than that for individuals in the advanced country. On the other hand, $W^*_{U,t}$ is lower than $W_{U,t}$ because both countries have the same efficient unit of unskilled workers but the advanced country has more efficient units of research workers and skilled worker. In other words, the opportunity cost of attending a teaching institution is lower in the less advanced country. Teachers from the advanced country can charge a higher tuition in the less advanced country because students get more return and face lower opportunity costs.

3.3.2 The impact of trade in teaching service

The exporting country

After establishing the pattern of trade, we can now analyze the BGP for both countries with trade in teaching service. Let T_X be the number of teachers who is from the advanced country but teaches in the less advanced country. In the advanced country, the labor market for graduates from the research institutions becomes $S_R = R + T_X + T + L_R$, and the steady state number of teachers in the domestic teaching sector is therefore determined by

$$\frac{\alpha_2(1+g)^{\alpha_1+\alpha_2}}{mT} - \frac{(1+r)\alpha_1}{m(kR-R-T_X-T)} - \frac{[(1+g)^{\alpha_1+\alpha_2}+(1+r)](1-\alpha_1-\alpha_2)}{2(N-kR-mT)} = 0 \quad (3.15)$$

Proposition 15. *Compare to the autarky BGP, in the education exporting country,*

1) there will be fewer teachers in their domestic teaching sector;

2) there will be fewer skilled workers, more unskilled workers, and fewer research workers in the production sector;

3) The government will impose a higher tax rate on the production.

4) The skilled and unskilled workers will have a lower income.

Proof. Let x^{Tr} and x^{A} denote the variables associated with trade equilibrium and the autarky equilibrium in steady state. Define

$$\Theta^{Tr} \equiv \frac{\alpha_2(1+g)^{\alpha_1+\alpha_2}}{nT} - \frac{(1+r)\alpha_1}{m(kR-R-T_X-T)} - \frac{[(1+g)^{\alpha_1+\alpha_2}+(1+r)](1-\alpha_1-\alpha_2)}{2(N-kR-mT)}.$$

Differentiate Θ^{Tr} with respect to T, we get

$$\frac{\partial\Theta^{Tr}}{\partial T} = -[\frac{\alpha_2(1+g)^{\alpha_1+\alpha_2}}{nT^2} + \frac{(1+r)\alpha_1}{m(kR-R-T_X-T)^2} + \frac{[(1+g)^{\alpha_1+\alpha_2}+(1+r)](1-\alpha_1-\alpha_2)m}{2(N-kR-mT)^2}] < 0.$$

For any T, $\Theta^{Tr} < \Theta$ as long as $T_X > 0$. The solution to $\Theta^{Tr} = 0$ has to be smaller than the solution to $\Theta = 0$, i.e., The number of teachers in domestic teaching sector of the advanced country T^{Tr} is smaller than the number of teachers in the teaching sector of the advanced country before trade, T^{A}. $T^{Tr} < T^{A} \Rightarrow L_S^{Tr} < L_S^{A} \Rightarrow L_U^{Tr} > L_U^{A}$.

Rearrange $\Theta^{Tr} = 0$ and $\Theta^{A} = 0$, we get

$$L_R^{Tr} = \frac{m}{(1+r)\alpha_1}[\frac{\alpha_2(1+g)^{\alpha_1+\alpha_2}}{L_S^{Tr}} - \frac{[(1+g)^{\alpha_1+\alpha_2}+(1+r)](1-\alpha_1-\alpha_2)}{L_U^{Tr}}]^{-1}$$

$$L_R^{A} = \frac{(1+r)\alpha_1}{m}[\frac{\alpha_2(1+g)^{\alpha_1+\alpha_2}}{L_S^{A}} - \frac{[(1+g)^{\alpha_1+\alpha_2}+(1+r)](1-\alpha_1-\alpha_2)}{L_U^{A}}]^{-1}.$$

$$L_S^{Tr} < L_S^A, L_U^{Tr} > L_U^A \Rightarrow L_R^{Tr} < L_R^A.$$

From the balanced budget condition of the government, we get $\tau = \frac{\alpha_1 R}{\alpha_1 R + L_R}$.

$$L_R^{Tr} < L_R^A \Rightarrow \tau^{Tr} > \tau^A.$$

The income of skilled and unskilled workers $I_{S,t} = I_{U,t} = [(1+g)^{\alpha_1+\alpha_2} + (1+r)]W_{U,t}$.

$$\frac{W_{U,t}^{Tr}}{W_{U,t}^A} = \frac{1-\tau^{Tr}}{1-\tau^A}(\frac{L_R^{Tr}}{L_R^A})^{\alpha_1}(\frac{L_S^{Tr}}{L_S^A})^{\alpha_2}(\frac{L_U^{Tr}}{L_U^A})^{-\alpha_1-\alpha_2} < 1 \Rightarrow I_{S,t}^{Tr} = I_{U,t}^{Tr} > I_{S,t}^A = I_{U,t}^A$$

□

Fewer teachers in domestic teaching sector leads to fewer skilled workers. The number of unskilled workers is the population who do not attend either research insitutions or teaching institutions, with a fixed population attending research insitutions, fewer people attend domestic teaching insitutions means more unskilled workers in production. To support the same number of researchers, the government has to raise tax rate because the production sector is negatively affected by exporting educational services.

The importing country

In the less advanced country, the labor market clearing condition for skilled workers changes to $L_S^* = m(T^* + T_X)$ and the labor market clearing condition for unskilled workers changes to $L_U^* = N - kR - m(T^* + T_X)$. The steady state number of native teachers in the less advanced country is determined by

$$\frac{\alpha_2(1+g)^{\alpha_1+\alpha_2}}{m(T^* + bT_X)} - \frac{(1+r)\alpha_1}{m(kR - R - T^*)} - \frac{[(1+g)^{\alpha_1+\alpha_2} + (1+r)](1-\alpha_1-\alpha_2)}{2(N - kR - m(T^* + T_X))} = 0$$

Proposition 16. *Compare to the autarky BGP, in the education importing country,*

1) there will have fewer native teachers in their teaching sector;

2) there will be more research workers and efficient units of skilled workers in the production sector;

3) the government will impose a lower tax rate.

Proof. Let x^{Tr*} and x^{A*} denote the variables associated with trade equilibrium and the autarky equilibrium in steady state. Define

$$\Theta^{Tr*} \equiv \frac{\alpha_2(1+g)^{\alpha_1+\alpha_2}}{m(T^* + bT_X)} - \frac{(1+r)\alpha_1}{m(kR - R - T^*)} - \frac{[(1+g)^{\alpha_1+\alpha_2} + (1+r)](1-\alpha_1-\alpha_2)}{2(N - kR - m(T^* + T_X))}$$

$$\Theta^{*} \equiv \frac{\alpha_2(1+g)^{\alpha_1+\alpha_2}}{mT^*} - \frac{(1+r)\alpha_1}{m(kR - R - T^*)} - \frac{[(1+g)^{\alpha_1+\alpha_2} + (1+r)](1-\alpha_1-\alpha_2)}{2(N - kR - mT^*)}.$$

Differentiate Θ^{Tr*} with respect to T^*, we get $\frac{\partial \Theta^{Tr*}}{\partial T^*} < 0$. $T^* \longrightarrow \min\{(k-1)R, \frac{N-kR}{m} - T_X\}$, $\Theta^{Tr*} \to -\infty$. Suppose $\frac{\alpha_2(1+g)^{\alpha_1+\alpha_2}}{mbT_X} - \frac{(1+r)\alpha_1}{m(kR-R)} - \frac{[(1+g)^{\alpha_1+\alpha_2}+(1+r)](1-\alpha_1-\alpha_2)}{2(N-kR-mT_X)} > 0$.[9] There exists a T^{Tr*} such that $\Theta^{Tr*} = 0$. For any T^*, $\Theta^{Tr*} < \Theta^*$ as long as $T_X > 0$. The number of teachers in domestic teaching sector of the less advanced country T^{Tr*}, i.e., the solution to $\Theta^{Tr*} = 0$, is smaller than the number of teachers in the teaching sector of the less advanced country before trade T^{A*}, i.e., the solution to $\Theta^* = 0$.

$T^{Tr*} < T^{A*} \Rightarrow L_R^{Tr*} > L_R^{A*}$.

$l_{S,t}^{Tr*} > l_{S,t}^{A*}$ is proved by contridition.

$$\frac{l_{S,t}^{Tr*}}{l_{S,t}^{A*}} = \frac{T^{Tr*} + bT_X}{T^{A*}} = \frac{\frac{(1+r)\alpha_1}{mL_R^{A*}} + \frac{[(1+g)^{\alpha_1+\alpha_2}+(1+r)](1-\alpha_1-\alpha_2)}{2L_U^{A*}}}{\frac{(1+r)\alpha_1}{mL_R^{Tr*}} + \frac{[(1+g)^{\alpha_1+\alpha_2}+(1+r)](1-\alpha_1-\alpha_2)}{2L_U^{Tr*}}}.$$

$$\begin{aligned} l_{S,t}^{Tr*} < l_{S,t}^{A*} &\Rightarrow T^{Tr*} + bT_X < T^{A*} \\ &\Rightarrow T^{Tr*} + T_X < T^{A*} \\ &\Rightarrow L_U^{Tr*} > L_U^{A*} \\ &\Rightarrow \frac{T^{Tr*} + bT_X}{T^{A*}} > 1 \end{aligned}$$

contridiction.

$\tau = \frac{\alpha_1 R}{\alpha_1 R + L_R}$. $L_R^{Tr*} > L_R^{A*} \Rightarrow \tau^{Tr*} < \tau^{A*}$. □

[9] If this condition does not satisfied, then with trade in educational services there will be no native teachers in the steady state. This may happen only if b the knowledge gap between the advanced and less advanced country is sufficiently big, which means the native teachers are driven out of the private teaching sector by the competition from the advanced country. In the proof, I assume this situation does not happen. The conclusion does not change without this assumption. With this corner solution of $T^{Tr*} = 0$, the number of native teachers is in fact smaller than a positive autarky level $T^{A*} > 0$.

One assumption for Proposition 14 to 16 is that the production technology is the same for both countries, so the autarky allocation of people is the same. Proposition 3 says as long as the advanced country has a higher knowledge level, it will have a comparative advantage in the teaching sector, and it will export education services to the less developed country. In reality, we observe variations in production technology, and advanced countries have relatively more skilled workers than less advanced countries. Developing countries, like China and Malaysia, were on a BGP with less skilled workers because their old technology was associated with a lower α_2. With a rapid inflow of foreign direct investments (FDIs) and their active participation in international trade, these countries are experiencing a technology upgrade, which increases the demand for skilled workers. On the transition to a new steady state, we observe a huge enrollments expansion in the domestic higher education sector in these countries and more commitments to liberalize trade in higher education. For these countries, importing education services from advanced countries is a more efficient way to increase the efficient unites of skilled worker. First, skilled workers educated by foreign teachers will have more efficient unit of skills. Second, more graduates from the domestic research institution can be freed from the teaching sector and work as research workers in the production sector. However, importing education services is not just a temporary phenomenon. This model predicts that after the developing countries achieve the new BGP, trade in higher education will still happen as in Proposition 14.

3.4 International Mobility of Research Students

In previous sections, it is assumed that the research institute only has access to the talent pool of its own population. However, we observe a large enrollment of international students in the research institutions in advanced countries, and a large portion of these students are from less advanced countries. For example, in 2000, 36% of U.S. Ph.Ds in the Science and Engineering (S&E) were granted to foreign-born. In 1996, students from China counts for 17% of all foreign PhD recipients from U.S. universities, followed by students from India, 13.8%, and then students from Taiwan, 13%. The data are a little outdated and the numbers may understate the current situation. In 2001, China enters the WTO and one of the commissions is to remove restrictions on student mobility. In 2002, the Ministry of Education (MOE) in China abolished the education and training fees imposed on students who want to continue their studying abroad. The education and training fees were 10,000 Chinese Yuan for 4-year college graduates, 22,000 for Master degree holders, and (22,000+6000*years in a PhD program) for students with some PhD studying experiences. The cost reduction in studying abroad may have a significant positive impact on the number of Chinese students studying overseas. How the mobility of research students affects the receiving and sending countries and whether these students would return to their home countries are important questions need to be investigated.[10] In this section, I incorporate international student mobility in the research sector into the model and try to throw light on these questions.

I assume ability is public information even across border and the research institutions send admissions to all individuals who meet their standard.[11] Since attending the advanced country's research institution means a higher human capital level next period, if there is no additional cost associated with attending a research institution overseas, individuals in the less advanced country will prefer admission from the advanced country. After graduation, these students should decide whether to stay in the advanced country or to return to the less advanced country.[12] If they stay, they can be a researcher or a teacher or a research worker.

I assume the economic environment in the advanced country is the same as

[10]Ricard Freeman (2005) describes some consequences of globalization of S&E workforce on the U.S. economic leadership. Without no formal model, he reasons that the effect may very likely to be negative.

Kim (1998) assumes that students will all return to their home country once they finish their studying. This assumption is not consistent with the data. According to Finn (2001), the stay rates of foreign doctorate recipients from U.S. universities increased from 49% in 1989 to 71% in 2001.

[11]With the rapid growth of international testing market, this assumption is more realistic than before. However, these tests are relatively costly for students from developing countries, which makes studying abroad less attractive.

[12]Assume all research students can get a working visa if they want to work in the country they get their advanced degree.

before except now the research institution will choose the number of researchers conditioned on its access to the talent pool of both countries. In this case,

$$S_{R,t} = S^h_{R,t} + S^f_{R,t} = kR_t S^h_{R,t} = S^f_{R,t},$$

so

$$\overline{a_{R,t}} = 1 - \frac{kR_t}{4N} A_{t+1} = (R_t)^{\varepsilon}(1 - \frac{kR_t}{4N})^{\gamma} A_t.$$

The research institution chooses R_t to maximize

$$h_{R,t+1} = (R_t)^{\varepsilon}(1 - \frac{kR_t}{4N})^{\gamma} A_t.$$

I use $x^{'}$ to denote the steady state level of x with international student mobility in the research sector. We get the number of researchers in the advanced country from the first-order condition of research institution's maximization problem.

$$R^{'} = \frac{\varepsilon}{\varepsilon + \gamma} \frac{4N}{k} = 2R$$

Having access to twice the talents, the number of researchers doubles in the advanced country. The admission cutoff for the research institution in the advanced country

$$a^{'}_R = \frac{\gamma - \varepsilon}{\gamma + \varepsilon}$$

is the same. Knowledge grows at a faster rate

$$1 + g^{'} = \frac{A_{t+1}}{A_t} = (\frac{\varepsilon}{\varepsilon + \gamma} \frac{4N}{k})^{\varepsilon} (\frac{\gamma}{\gamma + \varepsilon})^{\gamma} = 2^{\varepsilon}(1 + g).$$

In the less advanced country, individuals with ability $a > \frac{\gamma - \varepsilon}{\gamma + \varepsilon}$ attend the research institution in the advanced country. The research institution in the less advanced country selects the next best students, so the mean student ability

$$\overline{a_{R,t}}^* = a^{'}_R - \frac{kR^*_t}{2N}.$$

Given A^*_t and A_t, the research institution in the less advanced country chooses R^*_t to maximize

$$h^*_{R,t+1} = A^*_{t+1} = (R^*_t)^{\varepsilon}(1 - \frac{kR^*_t}{2N})^{\gamma}(\theta A^*_t + \lambda A_t).$$

From the first order condition, we get

$$R^{*'} = \frac{\varepsilon a_R^{'}}{\gamma+\varepsilon}\frac{2N}{k} = \frac{\gamma-\varepsilon}{\gamma+\varepsilon}R$$

The number of researchers in the less advanced country decreases in the less advanced country. The admission cutoff for the research institution decreases from $\frac{\gamma-\varepsilon}{\gamma+\varepsilon}$ to

$$a_{R,t}^{*} = (\frac{\gamma-\varepsilon}{\gamma+\varepsilon})^2.$$

Knowledge grows at a rate

$$\begin{aligned} 1+g_t^{*'} &= \frac{A_{t+1}^{*}}{A_t^{*}} \\ &= (\frac{\varepsilon(\gamma-\varepsilon)}{(\varepsilon+\gamma)^2}\frac{2N}{k})^{\varepsilon}(\frac{\gamma(\gamma-\varepsilon)}{(\varepsilon+\gamma)^2})^{\gamma}(\theta+\lambda\frac{A_t}{A_t^{*}}) \\ &= (\frac{\gamma-\varepsilon}{\gamma+\varepsilon})^{\varepsilon+\gamma}(\theta+\lambda\frac{A_t}{A_t^{*}})2^{\varepsilon}(1+g) \end{aligned}$$

The path of knowledge gap is given by the difference equation

$$\begin{aligned} b_{t+1} &= \frac{A_{t+1}}{A_{t+1}^{*}} \\ &= \frac{A_{t+1}}{A_t}\frac{A_t}{A_t^{*}}\frac{A_t^{*}}{A_{t+1}^{*}} \\ &= (1+g^{'})b_t\frac{1}{1+g_t^{*'}} \\ &= (\frac{\gamma-\varepsilon}{\gamma+\varepsilon})^{\varepsilon+\gamma}\frac{b_t}{\theta+\lambda b_t}. \end{aligned}$$

Use the same technique in section 3.2 to solve the steady state knowledge gap, we get

$$b_{t+1} = b_t = b^{'} = \frac{(\frac{\gamma+\varepsilon}{\gamma-\varepsilon})^{\varepsilon+\gamma}-\theta}{\lambda}.$$

The proof of existence, uqniqueness, and local stability of the knowledge gap is similar to the one without mobility of research students.

Let $S_{R,t}^{f*}$ be the number of individuals returned to the less advanced country after they graduate from the research institution in the advanced country. The return rate q_t is therefore $S^{f*}_{R,t}/S^{f}_{R,t}$. I start the investigation by looking at the steady state of the two economies assuming $q_t = 0$. Imagine there is some political reason that prohibits return behavior.

In the less advanced country, the labor market condition for unskilled workers becomes $L^*_U = N - kR^* - kR - mT^*$. The steady state number of native teachers in the less advanced country is determined by

$$\frac{\alpha_2(1+g)^{\alpha_1+\alpha_2}}{mT^*} - \frac{(1+r)\alpha_1}{m(kR^* - R^* - T^*)} - \frac{[(1+g)^{\alpha_1+\alpha_2} + (1+r)](1-\alpha_1-\alpha_2)}{2(N - kR^* - kR - mT^*)} = 0$$

Proposition 17. *Assume the research institution can recruit students from both countries and no student returns, in steady state,*

1) the advanced country will have more researchers, teachers, researcher workers, and skilled workers;

2) the advanced country will have a lower tax rate.

Proof. $R' = \frac{2(\gamma+\varepsilon)}{\gamma-\varepsilon} R^{*'} > R^{*'}$. Define

$$\Theta^{*'} \equiv \frac{\alpha_2(1+g)^{\alpha_1+\alpha_2}}{mz} - \frac{(1+r)\alpha_1}{m(kR^{*'} - R^{*'} - z)} - \frac{[(1+g)^{\alpha_1+\alpha_2} + (1+r)](1-\alpha_1-\alpha_2)}{2(N - kR^{*'} - kR' - mz)}$$

$$\Theta' \equiv \frac{\alpha_2(1+g)^{\alpha_1+\alpha_2}}{mz} - \frac{(1+r)\alpha_1}{m(kR' - R' - z)} - \frac{[(1+g)^{\alpha_1+\alpha_2} + (1+r)](1-\alpha_1-\alpha_2)}{2(N - kR' - mz)}.$$

The number of teachers in the advanced country, T', is the solution to $\Theta' = 0$. The number of teachers in the less advanced country, $T^{*'}$ is the solution to $\Theta^{*'} = 0$. Since $kR' - R' > kR^{*'} - R^{*'}$ and $N - kR' > N - kR^{*'} - kR'$, $\Theta^{*'} < \Theta'$. Combining with $\frac{\partial \Theta^{*'}}{\partial Z} < 0$ and $\frac{\partial \Theta'}{\partial Z} < 0$, so $T' > T^{*'}$. $T' > T^{*'} \Rightarrow L'_S > L^{*'}_S$. To prove $L'_R > L^{*'}_R$, we first divide Θ' by $\frac{2(\gamma+\varepsilon)}{\gamma-\varepsilon}$.

$$\frac{2(\gamma+\varepsilon)}{\gamma-\varepsilon}\Theta' = \frac{\alpha_2(1+g)^{\alpha_1+\alpha_2}}{m[z/\frac{2(\gamma+\varepsilon)}{\gamma-\varepsilon}]} - \frac{(1+r)\alpha_1}{m(kR^{*'} - R^{*'} - z/\frac{2(\gamma+\varepsilon)}{\gamma-\varepsilon})} - \frac{[(1+g)^{\alpha_1+\alpha_2} + (1+r)](1-\alpha_1-\alpha_2)}{2(N - kR^{*'} - mz/\frac{2(\gamma+\varepsilon)}{\gamma-\varepsilon})}.$$

$\Theta'/\frac{2(\gamma+\varepsilon)}{\gamma-\varepsilon} < \Theta^{*'}$, we get $T'/\frac{2(\gamma+\varepsilon)}{\gamma-\varepsilon} < T^{*'}$.

$$
\begin{aligned}
L_R^{'} &= kR^{'} - R^{'} - T^{'} \\
&= \frac{2(\gamma+\varepsilon)}{\gamma-\varepsilon}(kR^{*'} - R^{*'} - T^{'}/\frac{2(\gamma+\varepsilon)}{\gamma-\varepsilon}) \\
&> \frac{2(\gamma+\varepsilon)}{\gamma-\varepsilon}(kR^{*'} - R^{*'} - T^{*'}) \\
&> \frac{2(\gamma+\varepsilon)}{\gamma-\varepsilon}L_R^{*'} \\
&> L_R^{*'}.
\end{aligned}
$$

$L_R^{'} > L_R^{*'} \Rightarrow \tau^{'} < \tau^{*'}$. □

It is not clear which country will have more unskilled workers because even though the less advanced country has fewer students in its domestic research and teaching institutions, it has some extra students studying abroad. I will assume that the advanced country ends up with less unskilled workers to be consistent with data.

From this point, imagine the political reason that prohibits return behavior disappears. Now we ask this question – are there any incentives for students to return to the less advanced country? If there are, what occupation will these returnees choose?

Proposition 18. *Suppose some students who attend the advanced country's research institution are considering returning to the less advanced country. They will not choose to be a research worker in the production sector.*

Proof. If they return as research workers in the production sector, they will get paid by the marginal value of their human capital $W_{R,t}^{*h} = (1-\tau)\omega_{R,t}^{*}h_{R,t}^{*h} = bW_{R,t}^{*l} = bmp_t^{*l}$.

$$W_{R,t}^{*h} = mb\{(1+g)^{\alpha_1+\alpha_2}W_{S,t}^{*l} - [(1+g)^{\alpha_1+\alpha_2} + (1+r)]W_{U,t}^{*h}\}$$

The marginal income from returning to the teaching sector is

$$
\begin{aligned}
mp_t^{*h} &= m\{(1+g)^{\alpha_1+\alpha_2}W_{S,t}^{*h} - [(1+g)^{\alpha_1+\alpha_2} + (1+r)]W_{U,t}^{*h}\} \\
&= m\{(1+g)^{\alpha_1+\alpha_2}bW_{S,t}^{*l} - [(1+g)^{\alpha_1+\alpha_2} + (1+r)]W_{U,t}^{*h}\}
\end{aligned}
$$

Therefore, $W^{*h}_{R,t} - mp^{*h}_t = m(1-b)[(1+g)^{\alpha_1+\alpha_2} + (1+r)]W^{*h}_{U,t} < 0$, i.e., returning as a research worker in the production sector is dominated by returning as a teacher. □

In the field there is a big private education market, we observe a higher return rates. In 2001, students in management and commerce counts for 57% of Australian offshore students. Among the 110 joint programs in China, 83% are business and management programs. According to Finn (2001), for students receiving PhDs from U.S. universities in 1999, the stay rates for computer/EE engineering and economics are 83% and 47% respectively. This is consistent with Proposition 18. Demand for education in business and management science is mostly satisfied by private for-profit institutions. Ph.D.s in Economics have more opportunity to return as teachers than Ph.D.s in other field, so the return rates is much higher.

Proposition 3 proves that when trade barriers are removed, exporting education services to the less advanced country is preferred by students graduated from the research institution in the advanced country. This is because in the less advanced country the value of their educational services is higher and the opportunity cost of education is lower, which is easy to prove as the autarky allocation of workers and tax rate are the same for both countries. However, as in Proposition 7, with international student mobility in the research sector, the advanced country ends up with more researchers, teachers, research workers, skilled workers, a lower tax rate, and a higher mean ability of students in the teaching sector. So, Proposition 3 cannot be generalized to insure existence of returning of research students to the teaching sector in the less advanced country. But we can use the same logic to identify the conditions, under which return is preferred.

3.5 Conclusion

This paper employs a general equilibrium model with two large economies to investigate the impact of trade in educational services on both the exporting and importing countries. This model predicts that a country with a higher knowledge level will export education (teachers) to a country with a lower knowledge level. Moving from autarky to free trade, in the advanced country the domestic teaching sector will shrink and the number of research workers and skilled workers will decrease while the number of unskilled workers will increase. Overall, the advanced country experiences a deteriorating of labor force quality and an increase of the production tax. As a consequence, the income of skilled and unskilled workers decreases. In the less advanced country, the teaching sector will employ fewer native teachers, and the production sector will have more efficient units of research workers and skilled workers. Overall, the less advanced country experiences an improvement in the labor force quality and a decrease of the production tax.

The model incorporates mobility of research students to investigate the return behavior of students trained by institutions in advanced country. The model suggests that among the three occupations – researchers, teachers, and research workers, to return as teachers is the best choice conditioned on return. The model also suggests that when international knowledge spillover gets bigger in the research sector, the incentive of returning as teachers for these students decreases. These two predictions are consistent with the evidences: in the field of Economics, there is more opportunity to return as teachers, so the return rate is much higher, and overall, the return rates of foreign-born Ph.D.s decreased from 51% in 1989 to 29% in 2001.

3.6 Appendix

3.6.1 The existence, uniqueness, and local stability of a steady state knowledge gap

Proof. Differentitate $b_{t+1} = \frac{b_t}{\theta+\lambda b_t}$ with respect to b_t,

$$\frac{\partial b_{t+1}}{\partial b_t} = \frac{\theta}{(\theta + \lambda b_t)^2} > 0$$

and

$$\frac{\partial^2 b_{t+1}}{\partial (b_t)^2} = -\frac{\theta\lambda}{(\theta + \lambda b_t)^3} < 0.$$

If $b_{t+1} = \frac{b_t}{\theta+\lambda b_t}$ is drawn in the (b_{t+1}, b_t) plane, it is positive sloped and cross the 45^o line once. So, there exists a unique steady state where the knowledge gap is constant and $b = \frac{1-\theta}{\lambda} > 1$. The steady state is locally stable if the absolute value of the slope of the curve in the neighborhood of the steady state is less than one. The stability condition is satisfied as

$$\frac{\partial b_{t+1}}{\partial b_t}(b = \frac{1-\theta}{\lambda}) = \theta < 1.$$

□

3.6.2 Existence, uniqueness, and local stability of a BGP

Proof. Totally differentiate equation (3.14) with respect to T_{t-1} and solve for $\frac{dT_t}{dT_{t-1}}$,

$$\frac{dT_t}{dT_{t-1}} = -\frac{\frac{\alpha_2(1+g)^{\alpha_1+\alpha_2}}{m(T_{t-1})^2} + \frac{[(1+g)^{\alpha_1+\alpha_2}+(1+r)](1-\alpha_1-\alpha_2)m}{[(N-KR-mT_{t-1})+(N-kR-mT_t)]^2}}{\frac{(1+r)\alpha_1}{m(kR-R-T_t)^2} + \frac{[(1+g)^{\alpha_1+\alpha_2}+(1+r)](1-\alpha_1-\alpha_2)m}{[(N-KR-mT_{t-1})+(N-kR-mT_t)]^2}} < 0$$

If equation (3.14) is drawn in the (T_{t-1}, T_t) plane, it is negatively sloped and cross the 45^o line once. Therefore, there exists a unique steady state that the number of teachers in constant over time. The steady state is locally stable if the absolute value of the slope of the curve in the neighborhood of the steady state is less than one. The stability condition is

$$\frac{\alpha_2(1+g)^{\alpha_1+\alpha_2}}{T^2} < \frac{(1+r)\alpha_1}{(kR-R-T)^2}.$$

□

3.6.3 Proof of Proposition 14: Trade Pattern

Proof.

$$\begin{aligned}
\frac{W^{*h}_{S,t+1}}{W_{S,t+1}} &= \frac{\omega^*_{S,t+1}h^{*h}_{S,t+1}}{\omega_{S,t+1}h_{S,t+1}} \\
&= \frac{\alpha_2(l^*_{R,t+1})^{\alpha_1}(l^*_{S,t+1})^{\alpha_2-1}(l^*_{U,t+1})^{1-\alpha_1-\alpha_2}\overline{a_{T,t}}A_t}{\alpha_2(l_{R,t+1})^{\alpha_1}(l_{S,t+1})^{\alpha_2-1}(l_{U,t+1})^{1-\alpha_1-\alpha_2}\overline{a_{T,t}}A_t} \\
&= \frac{(L_R)^{\alpha_1}(\overline{a_{T,t}}L_S)^{\alpha_2-1}(L_U)^{1-\alpha_1-\alpha_2}(A^*_{t+1})^{\alpha_1+\alpha_2-1}}{(L_R)^{\alpha_1}(\overline{a_{T,t}}L_S)^{\alpha_2-1}(L_U)^{1-\alpha_1-\alpha_2}(A_{t+1})^{\alpha_1+\alpha_2-1}} \\
&= b^{1-\alpha_1-\alpha_2} > 1
\end{aligned}$$

$$\begin{aligned}\frac{W^*_{U,t}}{W_{U,t}} &= \frac{\omega^*_{U,t}}{\omega_{U,t}} \\ &= \frac{(1-\alpha_1-\alpha_2)(l^*_{R,t+1})^{\alpha_1}(l^*_{S,t+1})^{\alpha_2}(l^*_{U,t+1})^{-\alpha_1-\alpha_2}}{(1-\alpha_1-\alpha_2)(l_{R,t+1})^{\alpha_1}(l_{S,t+1})^{\alpha_2}(l_{U,t+1})^{-\alpha_1-\alpha_2}} \\ &= \frac{(L_R)^{\alpha_1}(\overline{a_{T,t}}L_S)^{\alpha_2}(L_U)^{-\alpha_1-\alpha_2}(A^*_{t+1})^{\alpha_1+\alpha_2}}{(L_R)^{\alpha_1}(\overline{a_{T,t}}L_S)^{\alpha_2}(L_U)^{-\alpha_1-\alpha_2}(A_{t+1})^{\alpha_1+\alpha_2}} \\ &= b^{-\alpha_1-\alpha_2} < 1\end{aligned}$$

$$mp_{X,t} = \frac{m}{1+r}[W^{*h}_{S,t+1} - [(1+g)^{\alpha_1+\alpha_2} + (1+r)]W^*_{U,t}]$$

$$mp_t = \frac{m}{1+r}[W_{S,t+1} - [(1+g)^{\alpha_1+\alpha_2} + (1+r)]W_{U,t}]$$

Therefore, $mp_{X,t} > mp_t$.

□

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